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THE

STUDENT'S INSTRUCTOR

IN DRAWING AND WORKING

THE FIVE ORDERS OF ARCHITECTURE.

FULLY EXPLAINING THE BEST METHODS FOR

STRIKING REGULAR AND QUIRKED MOULDINGS; FOR DIMINISHING AND GLUEING OF COLUMNS AND CAPITALS; FOR FINDING THE TRUE DIAMETER OF AN ORDER TO ANY GIVEN HEIGHT; FOR STRIKING THE IONIC VOLUTE, CIRCULAR OR ELLIPTICAL: WITH FINISHED EXAMPLES, ON A LARGE SCALE, OF THE ORDERS, THEIR PLANCEERS, ETC.; AND SOME DESIGNS FOR DOOR-CASES,

ELEGANTLY ENGRAVED ON FORTY-ONE PLATES—WITH EXPLANATIONS.

BY PETER NICHOLSON, ARCHITECT,

Author of the Mechanic's Companion, Carpenter's New Guide, Carpenter and Joiner's Assistant, &c.

THE SIXTH EDITION—CONSIDERABLY AUGMENTED AND IMPROVED.

PREFACE.

THE following treatise will be found particularly useful to students in Architecture. It contains a complete development of the methods of drawing and working the five orders, which may be said to be the foundation, the very A B C of the art of building: as from these, with their several proportions and variations, arises all that is great, elegant, or harmonious in the noblest structure; wherefore I most earnestly recommend to the student, to obtain a thorough knowledge of every order, its parts, proportions, and entire figure, as being absolutely necessary to ALL who aspire to eminence in this profession.

To this purpose the following work is well adapted, and gives, in the most detailed and accurate manner, examples of the five orders, their proportions and enrichments, according to the present taste; which are so completely explained by the lines, and the measurement on the plates, that a little attention will enable every person readily to comprehend the proportion, use, and situation of each member: and also the several methods adopted in calculating the parts, and for setting them off on rods for practice, to any scale. The manner of drawing them on paper is fully explained, and I must here advise the student to make a diligent practice of drawing the outlines to a large scale, so that the measures may apply with accuracy, before he proceeds to finish in

shading; by doing so, he will acquire a facility of manner, and an accuracy of eye in judging of the beauties of proportion, which will ever be of essential use to him.

The explanation of the Tuscan order is given very full, and as the same methods apply to each of the other orders, they are not repeated. It is scarcely necessary to observe, the height of the several columns is given according to the most esteemed masters; nevertheless, they may, with much propriety, be varied, to suit particular purposes or situations.

The method of describing quirked mouldings is new and easy, for practice, for any swell. I have shown a new method for striking the Ionic volute, which will produce that spiral curve with more elegance and regularity in the sweep, than by any other method I have seen.

That important branch of practice, glueing up of columns and capitals, is shown in a new and accurate manner, easy to be understood. I have also shown new and easy methods for diminishing of columns, and for making the flutes and fillets on them and on pilasters; which, with various other interesting matters, will, I hope, make the operative parts of the orders better understood, both in theory and in practice, than by any former publication.

P. N.

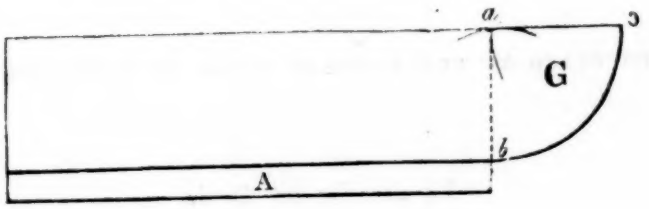
PREFACE TO THE THIRD EDITION.

THE usefulness of this little volume has been fully proved by the great numbers which have been sold: a new edition being now called for, I have examined the work throughout, and have made such corrections and additions as appeared to be necessary to adapt it to the prevailing style of architecture: to this purpose I have given a new plate containing a variety of *Modern Mouldings*, also six new ones of *Antique Doric Capitals* and entabulatures, with the parts at large and in detail: so that in this small work every member of these specimens of ancient magnificence is equally clear and distinct, as in the large work of the original author; and as I have reduced the proportions to the modular scale, they are more easily put in practice. Upon the whole, it will be found that the Greek Doric, which has of late been so much in vogue, is fully explained and elucidated. I have also given an example of a chaste and noble Ionic Capital; all these are selected from *Stuart's elegant and interesting work on the Antiquities of Athens*; the other new plates are an outline of the Composite Capital, for the use of learners, and an antique Ionic Door-case, proper to be drawn from or worked. These additions, on ten new plates, with various corrections in the descriptions, render this edition more complete and useful; and I think there is now nothing wanting to constitute it a complete introduction to the orders of architecture, both ancient and modern.

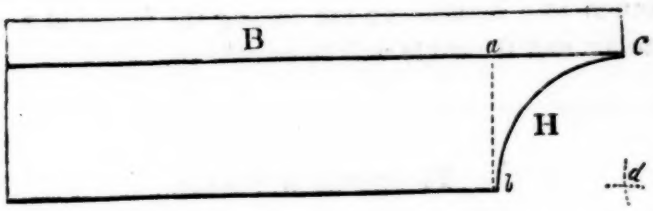
REGULAR MOULDINGS.

Plate 1.

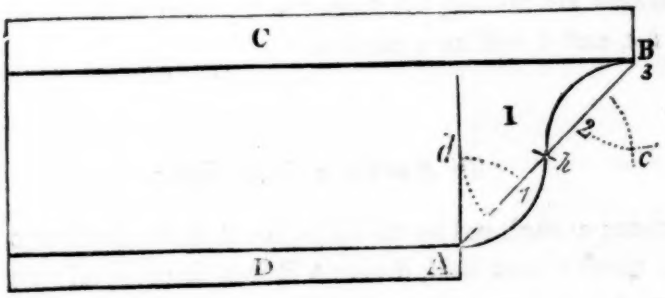
Ovolo.



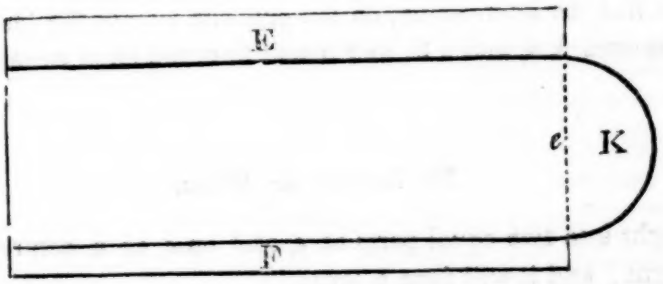
Cavetto



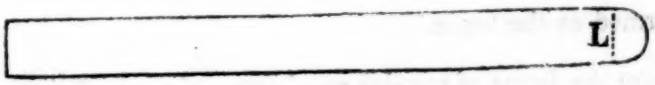
Cima Recta.



Torus.



Bead.



EXPLANATIONS, &c.

PLATE I.

TO DESCRIBE THE SEVERAL KINDS OF MOULDINGS.

To describe an Ovolo.

TAKE the height *a b*; set the compasses in *b*, describe an arc, and with the same distance on the projection at *c*, describe an arc cutting the former at *a*, then on *a*, as a centre, describe an arc *b c*, and the ovolo will be completed.

To describe a Cavetto.

On *b*, with the height *a b*, describe an arc on the projection at *c*, with the same distance describe another arc cutting the former at *d*; then with the same extension on *d*, describe the arc *b c*, and it will be a cavetto.

To describe a Cima Recta.

Join the projections at each end by the right line A B, divide it into two equal parts at *h*, and in order to make it look bold, divide A B into three equal parts, or nearly so, and with one third, on A and *h* as centres, describe arcs, cutting each other at *d*; and in the same manner find the intersection, on the opposite side of the line at *c*; lastly, on *d* and *c*, describe the arcs A *h*, and *h* B, and it will form the cima recta required.

To describe the Torus.

Divide the height into two equal parts at *e*, and on *e*, as a centre, describe a semicircle to that height; and it will form a torus.

The *Bead* is formed as the torus.

Note. These are the forms of regular mouldings, viz: the height equal to the projection: but there are other forms, where the projection is often less than the height, and the curvature of the moulding much flatter; however, the same methods for describing the one, will do for the other.

MODERN MOULDINGS.

Plate 2.

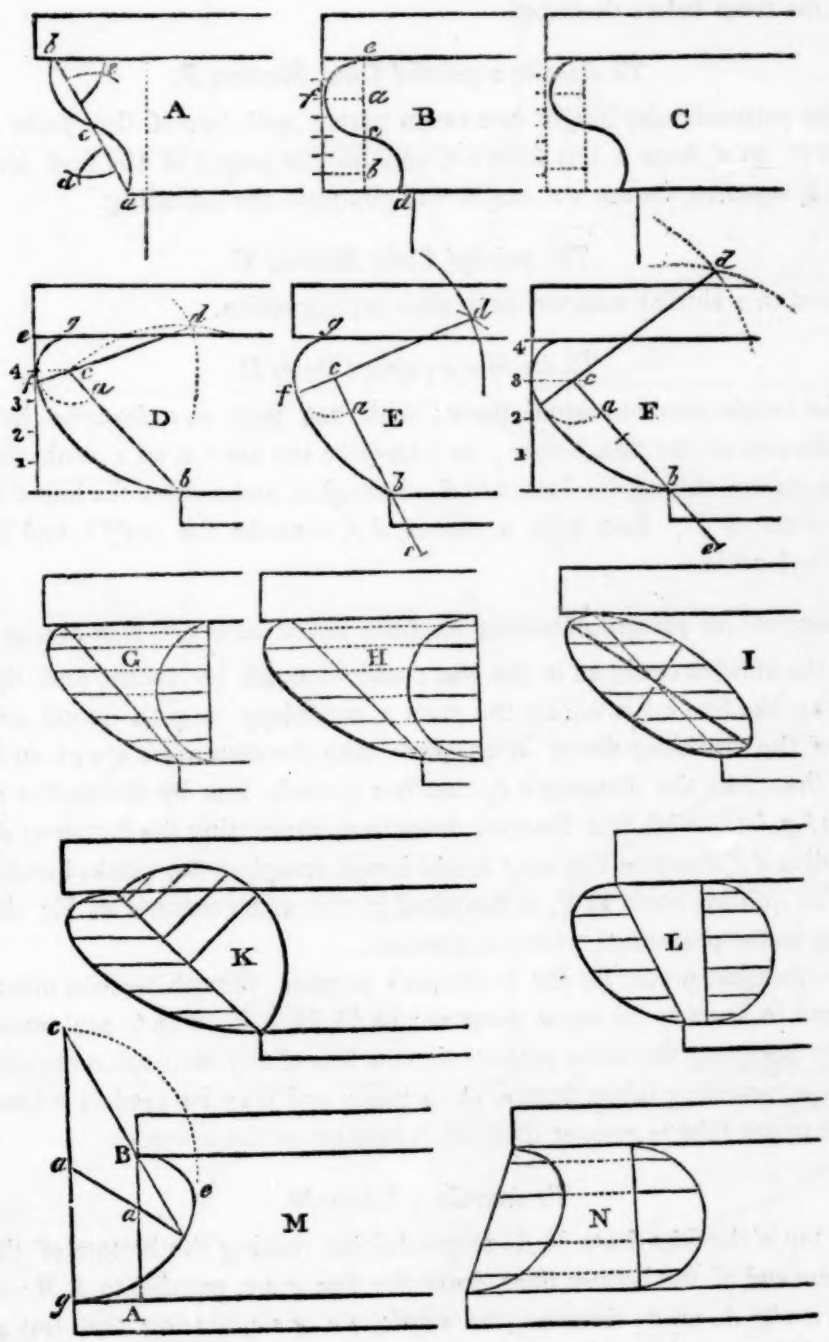


PLATE II.

MODERN OR QUIRKED MOULDINGS.

To describe the Cima Reversa A.

Join the projections at *a*, and *b*, by the line *a b*, and proceed in the same manner as with the cima recta before described.

To describe a quirked Cima Reversa B.

Divide the perpendicular height into seven parts; with two of the parts describe a semicircle *c e*; on *a*, draw a line from *e c*, and on the height of the first division from the bottom *b*, describe the arc *c d*, and it will complete the moulding.

The quirked Cima Reversa C

Is described in a similar manner, as is plain on inspection.

To describe a quirked Ovolo D.

Divide the height into four equal parts; with one part on *c*, describe the arc *a f g*. Join *c b* to the end of the fillet below; on *b* describe the arc *c d*, on *c*, with the distance *a b*, describe an arc cutting the former at *d*; through *d*, and *c*, draw the line *d c f*, cutting the small circle at *f*; then with a radius, *d f*, describe the arc *f b*, and it will complete a quirked ovolo.

To describe the quirked Moulding E, flatter in the lower part than that at D.

Describe the smaller circle as in the last; and through its centre, and the end *b* of the fillet, draw the line *c b e*, taking the point *e*, according as you intend to have the under part of the moulding flatter or quicker: take the distance *e c*, and on *b*, describe an arc at *d*, then take the distance *e a*, that is *e c*, made less by the radius *c a*, of the smaller arc *a f g*, on *c*, with that distance, describe an arc cutting the former at *d*; lastly on *d*, with a radius *d f*, describe the arc *f b*, and it will complete the quirked ovolo required.

Note. The quirked ovolo at F, is described in the same manner as E; the only difference being in the projection, which is greater.

These are the most proper for the workman's purpose, though various other methods may be shown to answer the same purpose; as G, H, I, K, which are traced from a semicircle, by applying the same projections to a line of any inclination required.

G, is a torus moulding taken from a semicircle; and may be applied where the projection of the upper fillet is greater than the projection of the lower.

To describe a Scotia M.

From the top of the fillet draw B A, perpendicular, cutting the bottom of the fillet at A: from *g* the end of the bottom fillet, draw the line *g a c*, parallel to A B: make *g a*, equal to twice *g* A, on *a*: describe the semicircle *g e c*, cutting the line *g a c*, at *c*, through *c*, and the end of the fillet, at B, draw the line *c* B *e*, cutting the semicircle at *e*: draw the line *a d e*, cutting A B, in *d*; lastly on *d*, describe the arc *e* B, and it will complete the scotia.

N is a scotia, described by a similar method to the ovolos, G, H, I, K, viz. through points found from a semicircle, to the height of the moulding.

MODERN MOULDINGS.

Plate 3.

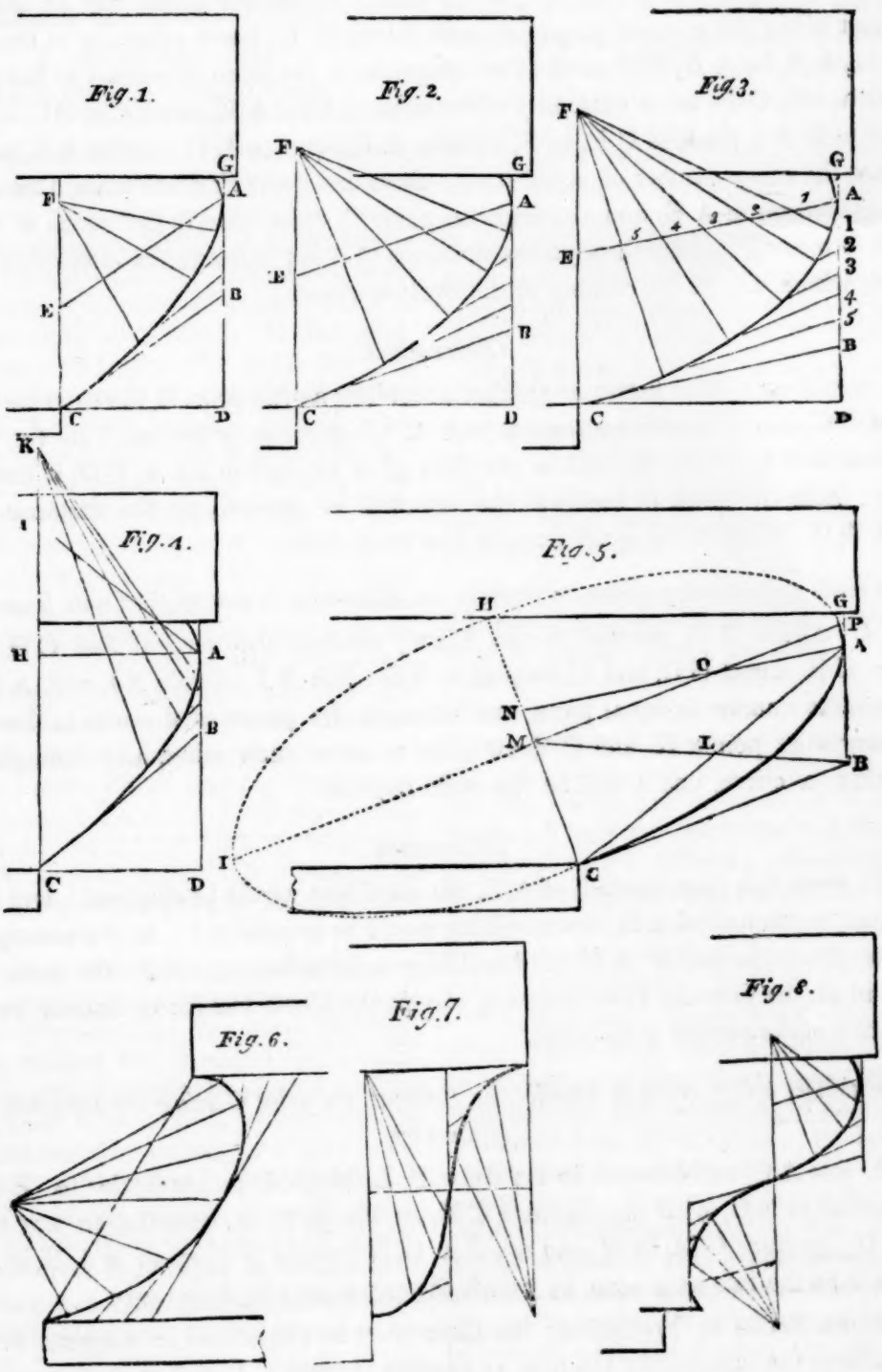


PLATE III.

MODERN MOULDINGS.

To describe a Grecian Ovolo or Echinus.

Have two tangents to the curve, and the points of contact given, one of the points of contact being the greatest projection, and the other the lower extremty of the curve.

Fig. 1, 2, 3, let A B, B C, be the two tangents, A the point of contact at the greatest projection, and C the lower extremity of the curve ; draw A E, parallel to B C, and C E, parallel to B A ; produce C E, to F, making E F, equal to E C ; divide A E, and A B, each into the same number of equal parts ; from the point F, draw lines through the points of division in A E, and also from the point C, draw lines to the points of division in A B, to meet the others through the divisions of A E ; through the intersections draw a curve, which will be the contour of the ovolo required.

Observations.

The moulding will be flatter or quicker according as the point B, the extremity of the tangent B C, is nearer or more remote from A, the greatest projection. In fig. 1, B D, is one half of A D ; in fig. 2, B D, is one third of A D ; and in fig. 3, B D, is one fourth of A D. Also the quirk or recess at the top will be greater, as the distance A G is greater, A G, being in the same straight line with A D.

The same things being given, to describe the Moulding to any of the Conic Sections.

Fig. 4. Draw A H, parallel to the fillets ; produce the vertical line C H, to K, making H K equal H C, and H I equal to B D : join A I ; divide A I, and A B, each into the same number of equal parts, and through the points of division in these lines, and through the points K, and C, draw lines to meet each other, and through these points draw a curve, and it will be the ovolo required.

Observation.

If B D, were less than the half of A D, the moulding would be elliptical ; and if B D, were equal to the half of A D, the moulding would be parabolical. In this example B D is greater than the half of A D, the moulding is hyperbolical. Of this form is the echinus in all the Grecian Doric capitals, except the Doric Portico at Athens, in which the echinus of the capital is elliptical.

The same things being given to describe the Echinus, the point C being the extremity of one of the axes.

Fig. 5, join A C, and bisect it in L ; draw B, L, M, C M, perpendicular to B C, and P M, parallel to B C, with the distance C M, on the point A, describe an arc cutting P M, at O : produce C M, to N, and draw A, O, N ; make N P, equal to A N, and M P and M will be the two semi-axes by which the curve may be described.

Fig. 6, is a Scotia or Trochillus ; the fillets may be considered as tangents, and the line parallel to the line joining the fillet as another tangent. Fig. 7, a cima-recta, compounded of two quarters of an ellipse upon the axes. Fig. 8, a cima reversa, compounded of two quarters of an ellipse from conjugate diameters, which are given in position. These are described upon similar principles to figures 1, 2, and 3.

Applications of Chemistry to the Useful Arts, being the substance of a Course of Lectures delivered in Columbia College, New-York, by James Renwick, Professor of Natural Experimental Philosophy and Chemistry.

I.

ACIDS OF COMMERCE.

1. SULPHURIC ACID.

AUTHORITIES.—PARKES. Chemical Essays.
DUMAS. Chimie appliquee aux arts.

History.—Sulphuric acid was originally prepared by the distillation of the sulphate of iron, in a mode that we shall have occasion to mention, as still used in manufacturing it for a special use. As this sulphate was known by the name of green vitriol, the acid was called oil of vitriol. It was afterwards discovered that the combustion of sulphur under vessels moistened with water, produced the same result. Finally, after the reception of the modern theory of chemistry, Lefevre and Demerey conceived that the oxidation of the sulphur might be promoted by mixing it with nitre, a salt whose acid is easily decomposed. Their experiment fulfilled their expectations, although their view of the rationale is now known to be erroneous. The operation was at first performed in large glass vessels, but as these are expensive, leaden chambers were substituted, and finally when the several steps of chemical action which occur in the process were investigated, a method was discovered in which the use of nitre might be dispensed with. Nitre is however still employed in most of the manufactories in this country and England.

Rationale.—When nitrous oxide (deutoxide of nitrogen) and sulphurous acid are introduced together into the same receiver, they mix without any chemical action upon each other; but if oxygen be present, nitrous acid gas is at once formed, whose presence will be manifested by a quantity of red fumes. This last named gas will also remain unacted upon by the sulphurous acid, unless they be also mingled with the vapor of water. But when this vapor is mixed with them, the red vapors gradually disappear, and a white crystaline solid is deposited on the sides of the receiver. These crystals are a compound of sulphuric acid, nitric acids and water. This crystaline substance is highly deliquescent, so that if the bottom of the receiver is covered with water, they fall into it and dissolve with a slight effervescence; the water becomes charged with sulphuric acid, nitric oxide is evolved, and in coming into contact with oxygen is again converted into nitrous acid gas. It is only necessary to supply a new quantity of sulphurous acid, and the formation of the solid substance may be again repeated, and an additional quantity of sulphuric acid obtained.

It is therefore obvious, that sulphuric acid may be formed by burning sulphur in a chamber whose floor is covered with water, and into which nitric oxide is introduced in any manner whatsoever, for the combustion of the sulphur will furnish sulphurous acid, and the spontaneous evaporation of the water the quantity of its vapor which is necessary.

Nitric oxide may be furnished by the action of burning sulphur upon nitre. And on this fact the most usual process depends. It may also be obtained by the action of sugar or of starch upon nitric acid. On the latter fact the new and improved process is founded.

Manufacture by a mixture of Sulphur and Nitre.—The chambers in which sulphuric acid is manufactured are made of sheet lead. They are of a rectangular shape. The bottom is raised about six feet from the ground, and supported by stone flags; the sides and top are sustained by a wooden frame, and a space of about six feet is left between this frame and the walls and roof of the building which contains it. The separate sheets of lead are carefully soldered together, and are united to the frame by clamps of lead soldered to their outer surface.

Single chambers have been constructed of all dimensions, from 5,000 to 100,000 cubic feet, and they have been made of smaller size, but so arranged as to communicate with each other. It does not appear that the exact shape and dimensions which are most favorable have yet been discovered. At any rate, a quantity of sulphuric acid proportioned to the sulphur consumed has never been obtained. A bed of water a few inches in depth is spread over the floor of the chamber. Immediately above this, a door, covered with lead, is placed, by which the materials are introduced. These are sulphur mixed with not less than one-eighth of its

weight of nitre. They are placed in a shallow vessel of earthenware or cast-iron, mounted on a wheel carriage, and, after being ignited, are shoved in through the door, which is shut after them. When the combustion is completed, and the acid condensed in the water, the carriage is withdrawn, the residuum taken out of the vessel; it is then charged with a fresh quantity of the mixed materials, and re-introduced after they have been ignited. These successive combustions are continued until the liquid at the bottom of the chamber acquires a density of 1.375 to 1.5.* Beyond the latter limit, condensation is unprofitable, because the attraction of the acidulated liquor for the sulphuric acid diminishes, and nitrous acid gas begins to be dissolved by it. This gas is separated with difficulty, and impairs the useful qualities of the acid.

The liquor having reached the above degree of concentration in the chambers, is removed from them to leaden boilers, where, by the aid of heat, it is further concentrated to 1.7†. Beyond this the concentration cannot be carried in a leaden vessel, for fear of melting the metal.

The acid liquor is therefore next placed in close retorts. These were originally, and are still, in most manufactories, made of glass, and set in an iron sand bath; in them the acid is brought, by the evaporation of the water in which it had been condensed, to the specific gravity of 1.84.‡ This is the greatest strength of the acid of commerce, and is sufficient for all practical purposes.

Glass retorts are liable to frequent breakage, in consequence of the violent agitation with which the separation of the bubbles of steam from the acid is attended. The size of the bubbles may be lessened, and the risk of breaking diminished by the introduction of angular fragments of glass, or strips of platinum, into the retort. But it would be far better to employ, as has been done in some French establishments, retorts of platinum. The only objection to these is their original cost, but when a sufficient capital can be obtained, the cost of the acid is lessened by employing them.

An improvement in this process was effected by Chaptal, who succeeded in making the action of the chambers perpetual, instead of intermitting, by burning the mixture of sulphur and nitre in a separate furnace, directing the current of gases evolved from it through the chamber by means of flues, and forming a draught by means of a chimney. This method is attended with difficulties and a risk of loss, if not carefully managed; but, when well conducted, it gives a larger quantity of acid than the other. The first described method yielded, in its earlier stages, no more than 150 pts. for 100 pts. of sulphur. As it ought to produce 318 pts. of acid at 1.84, more than one half is lost. By more careful management, the product has been raised to 240 pts., but the method of Chaptal has yielded 300, involving a loss of no more than 6 per cent. To give it this superiority, it is however necessary to form the apparatus of several successive chambers communicating with each other; and where the method was most completely successful, the last chamber communicated with the chimney by a sloping channel, along which a stream of water was made to flow. The method of Chaptal, too, is dependent for its results upon the scientific skill of the persons who direct it, and even with every precaution, is not certainly successful.

Improved Method of Manufacture.—The method which is on all accounts the best, is that of Payen. We shall, therefore, describe it in detail.

The chamber of lead has a capacity of about 20,000 cubic feet, and is of the following dimensions:

Length, 50 feet.
Breadth, 27 "
Height, 15 "

From one end of the top two chimnies rise to a height of at least 15 feet. These are about 18 inches square, and communicate with the chamber by water-valves, so constructed as to prevent any return of gas downwards, without interfering with the upward draught, but also capable of being opened for the re-admission of atmospheric air, when the process is completed.

At the opposite end of the chamber, a circular hole of 8 feet in diameter is made in the leaden floor. To this a cylinder of sheet lead is soldered, which rises about 10 inches into the chamber, and projects about 7 feet beneath it. The lower end of this cylinder is turned inwards, and bent up so as to form a circular channel, in which a

* 40° to 50° of Beaume's hydrometer.
† 60° of Beaume. ‡ 66° of Beaum

quantity of acid liquor is constantly kept, for the purpose of preventing the lead from being melted by the burning sulphur. The heat, which is thus prevented from reaching the lead, serves to concentrate the acid liquor.

Within the opening left in the bottom of the cylinder, a circular plate of cast-iron is placed, about 3½ feet in diameter, and slightly concave on its upper surface. Beneath this plate is a furnace, by which it may be heated until it becomes capable of inflaming the sulphur.

The sulphur is introduced by a door made in the side of the cylinder, about 2 feet in height and 18 inches in breadth. At the lower part of this door is a small hole about one inch in diameter.

By the same door a small capsule of platinum may be introduced, which is separated from the plate which receives the sulphur, by an iron tripod.

In the vicinity of the chamber, a steam boiler with its furnace and chimney are placed. This boiler communicates with the middle of the chamber by a pipe 1 inch in diameter, having a plate at its extremity, by which the opening is reduced to a circle of the diameter of ½ inch. The fire surface of this boiler is about 5 square feet.

In order to commence the process, the door in the cylinder and the valves of the chimnies are closed; a fire is lighted in the furnace, and when the plate is so far heated as to inflame a teaspoonful of sulphur thrown upon it, 100 lbs. of sulphur are put in. At the same time the platinum capsule is charged with a mixture of 9 lbs. of nitric acid, and 1 lb. of molasses. From this mixture nitric oxide is disengaged in great abundance, and pouring upon the surface of the sulphur, is speedily mixed with sulphurous acid.

While this action is going on, the water in the steam boiler is heated; at the end of about two hours from the introduction of the sulphur, a stopcock upon the pipe is opened, and the steam permitted to enter the chamber. In a few minutes, a condensation begins, which renders it necessary to admit atmospheric air, in order to prevent collapse. This is done by opening the circular hole in the door by which the charge is introduced.

The injection of steam is continued for an hour after the nitric acid sulphurous vapors are condensed. It is then permitted to condense in its turn. When this vapor is wholly condensed, the door and the valves in the chimnies are opened, in order to give free access to atmospheric air, and when the ventilation is complete, they are again closed, preparatory to a renewal of the operation.

The form of the apparatus may be better understood by the annexed plate. (Fig. 1.)

AABB, section of leaden chamber, whose bottom BB is inclined, in order that the stratum of water CC may be drawn off, after it is charged with acid.

D, cylinder of sheet lead, turned up at the lower end, so as to form a channel, which contains a layer of acidulated liquor, EE.

FF, concave plate of iron for burning the sulphur, which is heated by the furnace G.

H, chimney.

I, valve to prevent the entrance of air.

K, steam-boiler.

LL, pipe which conveys steam from the boiler to the chamber.

M, stopcock.

N, furnace for heating the steam-boiler.

O, capsule of platinum to receive a mixture of nitric acid and molasses.

As many as four charges may be consumed in this apparatus in 24 hours; but it is better to be content with three, or even two. In the latter case, the condensation is more complete, and the product from a given quantity of sulphur, larger; the chamber, also, is less liable to injury.

This method gives, with ordinary care, as large a product of acid as that of Chaptal, say 300 pts. for 100 of sulphur.

The nitric acid is not wasted, for by its action on the molasses, a quantity of oxalic acid is obtained, whose value is more than equal to their joint cost.

Sulphuric Acid, of Nordhausen.—Common sulphuric acid contains water as one of its essential constituents, and is, therefore, a hydrate. But sulphuric acid may also exist uncombined with water. In this state it is solid at ordinary temperatures. The sulphuric acid of Nordhausen is made up of various proportions of hydrated and anhydrous acid; it also contains sulphurous acid, whose presence is accidental. This acid is made at Nordhausen, by the distillation of sulphate of iron, but the details of the process have not been made public. The following method will, however, give a similar product.

Fig. 1.

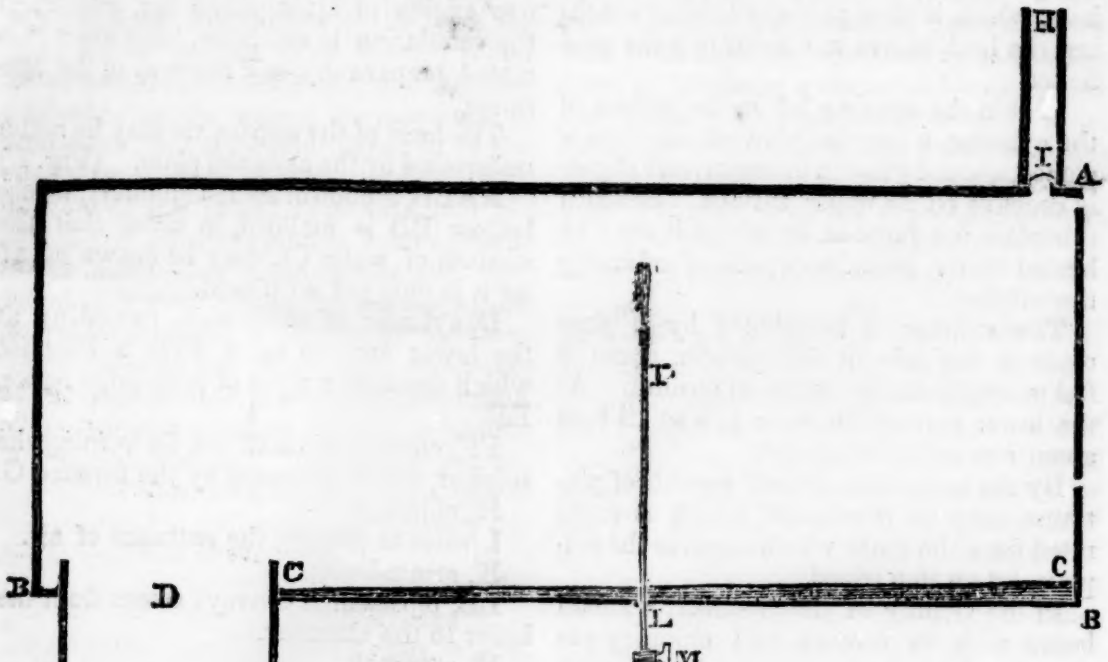
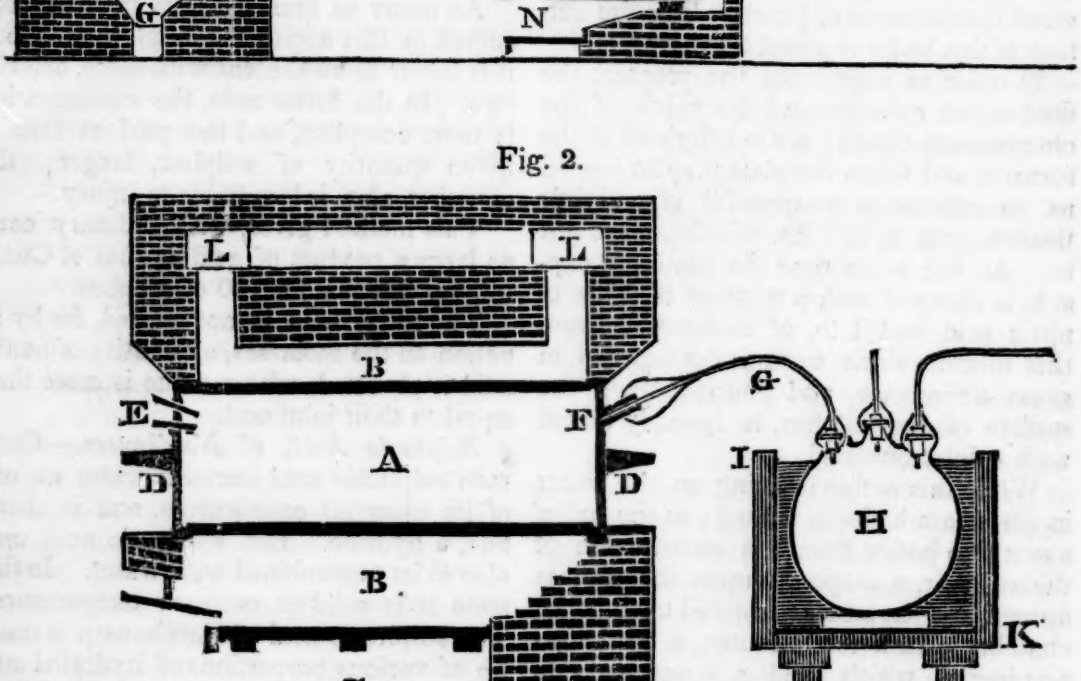


Fig. 2.



Dry sulphate of iron is placed in an earthen retort, the neck of this is luted to a receiver charged to about half its depth with common sulpuric acid, in which the anhydrous acid driven by heat from the sulphate of iron is condensed. In manufactures on a large scale, several globular receivers communicating with each other, would be necessary, and cylinders of earthenware might be substituted for the retort.

2. MURIATIC ACID.

AUTHORITIES.—PARKES. Chemical Essays.
DUMAS. Chimie appliquee aux arts.

History.—Muriatic acid was at first manufactured only on the small scale, and in glass vessels. Vessels of earthenware were next substituted, and to these succeeded retorts of lead. The lead retorts being found incapable of bearing a sufficient heat, were replaced by cast-iron kettles, closed by covers of lead. The last named method is still employed in England. The manufacture of soda from common salt having become a process of much importance in France, a simple and ingenious apparatus was constructed for the purpose of decomposing salt by sulphuric acid. At first, the quantity of muriatic acid gas which was thus set free, was so great that if condensed, it would have been unsaleable; but as the applications of the liquid acid in the arts became more extensive, condensing apparatus were connected with that for the decomposition of the salt.

Manufacture.—The best apparatus for the decomposition of salt by sulphuric acid, is composed of several cylinders of cast-iron. Each cylinder is about five feet in length, and eighteen inches in diameter. The thickness of the metal is about one inch. The cylinders are arranged horizontally and in pairs, each pair being built into a separate furnace, and the flues from ten such furnaces are united in a single chimney. The ends of the cylinders reach the surface of the masonry of the furnace. The two ends of each cylinder are closed by disks of cast-iron, an inch in thickness. Each of these disks has a handle cast upon it, and a small tube cast in an inclined direction. The position of these tubes is higher than the horizontal diameter of the disk, and the inclination towards the interior of the cylinder is downwards. One of these tubes is used for the introduction of the acid, the other conveys the gas to the condensing apparatus.

The condensing apparatus is formed of a number of three necked vessels, similar in form and use to the bottles of Wolf's apparatus. They are arranged in two rows, of twenty each. Each vessel of the first row receives gas from one of the cylinders, by means of a bent tube, and is also connected by bent tubes with the two contiguous vessels, with the exception of the first and last vessel of the row. In the first vessel, the third neck is closed, but the last has a pipe connected with it, which conveys the gas which has not been condensed to the corresponding vessel of the second row, which becomes first in order. The number of vessels in the second row is the same as in the first, and they are connected by bent tubes in such manner that the gas passes into them in regular succession, until the whole is condensed. The first row of vessels is kept cool by immersing them in a cistern of water; this is slowly changed by admitting cold water at the bottom of the cistern, and allowing the heated water to run off at top. The arrangement of a cylinder and the condensing apparatus may be understood by reference to the annexed plate. (Fig. 2.)

A, cast-iron cylinder.
BB, furnace.
C, ash-pit.
DD, circular disks to close the ends of the cylinder.
E, tubes by which sulphuric acid is introduced.
F, tube to which the glass tubes which convey the gas are luted.
G, glass tube.
H, glass receiver, with three necks.
IK, trough filled with water.
LL, flues.

Each cylinder is charged with 160 lbs. of salt, and to this is added, after the several joints have been closed by luting; 134 lbs. of sulphuric acid, of the density of 1·8.* The furnace must be so constructed that the cylinders shall be completely enveloped in the flame, in order that they may not be broken by unequal expansion. The fire is made as brisk as possible at first, and diminished when the gas comes over freely. At the end of the process the heat is again raised, in order that the residuum may be

*65° of Beaume.

left in a liquid state, and thus be more easily discharged from the cylinder.

Each of the vessels of the condensing apparatus must be half full of water, which will conduce about 1-5th of its weight of gaseous acid. The purest acid is condensed in the second row of vessels; that which is condensed in the first, contains a little sulphuric acid, and sometimes sulphate of soda, and chloride of iron.

By this method 100 parts of common salt give 130 parts of liquid acid of the density of 1.190*, and the loss is no more than about 9 per cent. By other processes little more than half the quantity is obtained.

3. NITRIC ACID.

AUTHORITY.—DUMAS. Chimie appliquee aux arts.

History.—Nitric acid is prepared in laboratories by the action of sulphuric acid upon nitric (nitrate of potassa.) The first attempt at manufacture on a large scale, was by the decomposition of nitre by means of clay in earthen retorts. Since the improvements in the manufacture of sulphuric acid, the action of this acid on nitre has been also made use of on a large scale.

The best apparatus for decomposition is composed of iron cylinders, exactly similar to those described as used in the manufacture of muriatic acid. Four of these are arranged in a single furnace. The condensing apparatus is composed also of three necked bottles; four rows of these are necessary, the two first of which are immersed in a cistern of water.

The cylinders are charged each with a mixture of nitrate of potassa, and the strongest sulphuric acid of commerce, in the proportion of 100 parts of the former to 60 of the latter. The nitre ought to be purified.

The several joints are luted with clay, which is covered with loam, mixed with horse-dung. The heat must be gradually raised, and well regulated. The process is known to be nearly finished when red fumes no longer appear in the glass tubes; a sudden increase of heat is then given, in order to separate the residue of the acid. The fire is then extinguished, the heads of the cylinders opened, and the sulphate of potassa which remains is easily taken out by iron tongs. The acid condensed in the first row of bottles contains sulphuric acid, and is the least pure. That condensed in the second, and part of the third rows, contains no other impurity but nitrous acid gas, and chlorine. These may be separated by boiling in glass retorts. The acid ought then to be colorless, and have the density of 1·333,* in which state it is brought into the market. The liquor in the last row of vessels is weak, and is placed in a succeeding process in the first and second rows, in order to receive a higher charge of acid. The two last rows of vessels must always be charged with pure water, in order that the condensation may be complete.

II.

ALKALIS OF COMMERCE.

1. *Pot and Pearl Ashes, and Salt of Tartar.*—The basis of these several substances is potassa combined with carbonic acid. This compound retains an alkaline reaction, and is therefore properly a subcarbonate, although usually called the carbonate of potassa. This carbonate is rendered impure by the mixture of earthy and vegetable matter, and some metallic oxides. Of these, potash contains the greatest quantity, and salt of tartar the least.

Potash is prepared from wood ashes, which are made in great quantities in clearing wood land in order to bring it into cultivation. This product is of so much value, that during the wars of the French revolution, when, for reasons hereafter to be mentioned, it maintained a high price, the whole cost of clearing our forests was defrayed by it.

As practised in this country, the art of making potash begins by piling logs in heaps, in the fields whence they are cut. These, when sufficiently dry, are set on fire, and burnt to ashes. It is better that a trench be formed in which to build the pile, in order that the combustion may be gradual, for when it is too rapid a part of the ashes is carried off by currents of air.

These ashes are then lixiviated, and the ley evaporated to dryness. The lixiviation is performed in tubs, or vats. A hole is pierced in the bottom of each of these, to which a spiggot is applied; this hole is covered with a piece of earthenware, to prevent it from being choaked. The bottom of the vat is covered with straw, on which a piece of canvass is laid. The rest of the vat is filled with dry ashes. Water is gradually added to the ashes, until they are

23° of Beaume.

*36° of Beaume.

thoroughly moistened, in which operation they subside, and the space which is thus left is filled up with water. The whole is left at rest for 12 hours, when the spiggot is withdrawn, and the liquor permitted to escape. The tub is again filled with water, which remains in contact with the ashes for two or three hours, when it is drawn off; and this operation is repeated until the alkaline matter in the tub is exhausted. The weak liquors last obtained are heated and used to lixiviate fresh ashes. The earlier runnings are evaporated in cast-iron vessels having the shape of a portion of a sphere, and which are known by the name of potash kettles. It is more convenient to prepare it for these, in evaporators of sheet-iron, which may also be used to heat the weak liquors, which are to be used a second time in lixiviation. When evaporated to dryness, the lower part of the mass in the kettle is partially fused, and the whole forms a hard cake, which must be broken by a mallet and chisel.

In this form it is packed into casks, and known in commerce by the name of potash. It is of a brown color, owing to the presence of soluble vegetable matter. As it is deliquescent, it is liable to damage from exposure to the air.

Damaged potash, and that of inferior quality, is converted into pearlash by exposing it to heat in an air furnace. This furnace is heated with wood, and is composed of a horizontal hearth covered by an arch, on which the potash is laid, and two fire-places. The smoke and heated air escape on the side of the hearth opposite to that on which the furnaces are placed. The same opening which permits the escape of the smoke serves for the introduction of the potash. The heat is sufficient to fuse the potash, which would adhere to the hearth were it not stirred. About an hour after the fusion is complete, the vegetable matter takes fire, and is converted into carbonic acid and vapor of water. If chloride of potassa is present, it is decomposed and decrepitates at the commencement of the operation. The substance thus becomes white, with the exception of a few stains of a violet color, which are owing to the presence of the oxides of iron and manganese.

Salt of tartar is prepared from the lees of wine, in countries where that liquor is manufactured. In the several decantations to which it must be subjected, solid matter is left in the tons and casks. This is put in bags and pressed. The paste thus obtained is bent, by the pressure, into the form of a roofing-tile, and is dried upon planks in the sun.

These masses are then burnt on a circular floor of well beaten earth, about six feet in diameter, which is surrounded by a wall of brick without mortar, about 8 inches in height. A faggot of twigs is placed in the centre and set on fire; this is surrounded by about 20 of the dry cakes. As soon as they are inflamed, more cakes are added, until the space inclosed within the wall is filled. The wall is then gradually raised and the heaps of lees increased, until all that have been prepared are consumed, if less than 1000 cakes, at which number the process ceases. The combustion is to be maintained in a regular and steady manner, by varying the quantity of the lees which are added.

The ashes obtained weigh about one-sixth of the weight of the lees employed, and contain about half their weight of carbonate of potassa. They are therefore sufficiently rich to be used, without further preparation, in several arts; but in order to obtain the salt of tartar, they must be lixiviated, and the ley evaporated to dryness.

2. *Barilla, Kelp and Sal-Soda.*—Barilla and kelp contain a carbonate of soda analagous to that of potassa, which is procured from the ashes of wood. They are obtained from marine plants, or those which grow in the immediate vicinity of salt water. Barilla is manufactured from the *salsola soda*, which is cultivated in great quantities on the Mediterranean coast of Spain, for the purpose. The plants, when they have attained their full growth, are cut and dried in the air. They are then burnt in pits about a yard in depth and 3½ feet square. The combustion lasts several days, and the product is a hard, compact mass, partially fused. It is so rich in soda that it is not necessary to lixiviate it, but it may be employed in many of the arts without any further preparation. The quantity of carbonate of soda varies from 25 to 30 per cent.

An inferior quality of barilla is prepared in the south of France, from the *salicorna annua*. This does not contain more than 15 per cent. of carbonate of soda.

Kelp or wareck is made on the north coast of France, and on those of Scotland

and Ireland, from sea weed, (*fucus*,) which grows abundantly on the rocks which are within reach of the tide. It does not contain more than from 3 to 5 per cent. of carbonate of soda. It contains, however, a large proportion of the sulphate of soda and potassa, and the chlorides of their metallic bases. It may, therefore, be employed as a substance rich in alkaline matter, under circumstances which will insure the decomposition of the sulphates, and the conversion of the chlorides into oxides. The iodides of potassium and calcium are likewise constituent parts both of barilla and kelp, and the greater part of the iodine used by chemists is obtained from them.

The substance known in the shops as sal-soda or common soda, is usually obtained from barilla or kelp, by lixiviation and crystalization, so conducted as to separate the several soluble matters in the order of their respective solubilities.

The carbonate of soda, which exists in barilla and kelp, has an alkaline reaction, and is composed of one equivalent of soda to two of acid. Another carbonate is used in the manufacture of soda water, which is composed of one equivalent of soda to three of acid. The same salt exists native in Africa, and is known under the name of nation.

(To be continued.)

From the Journal of the Franklin Institute.

On the Transport of Heavy Burthens upon Ice. By Thomas Jefferson Cram, Prin. Assist. Prof. of Nat. and Exp. Philos., U. S. Mil. Acad.

TO THE COMMITTEE ON PUBLICATIONS.

Gentlemen,—Having seen an account of the following experiments on the resistance of ice, by Assistant Professor Cram, I deemed it of sufficient interest to your readers to request from him permission to publish it. He has kindly furnished the following abstract, which is transmitted for publication. Very respectfully, yours,

A. D. Bache.

West Point, Oct. 7th, 1835.

Dear Sir,—For ordnance purposes, it became necessary, on the 13th of January, 1835, to transport a heavy piece of artillery (an iron 24 pounder) across the Hudson, from West Point to Cold Spring Foundry. To insure safety, two ox sleds were connected, one after the other, and upon which two timbers were longitudinally placed and secured; between these timbers, the gun, previously dismounted from its carriage, was swung, by resting its trunnions upon them, at such points that the whole pressure was distributed, as uniformly as possible, upon the ice which sustained it. A pair of horses were attached to another sled, which was connected with the foremost of those before named, by a rope about thirty feet in length.

The ice over which the gun was taken, had been chiefly formed during that intensely cold week, (in January, 1835,) when the mercury in Fahrenheit's thermometer ranged, here, between $-2\frac{1}{2}$ and -15. The effects of the pressure upon the ice were carefully observed, by myself, along the entire route, and were such as to induce the belief, that an idea of its strength could be formed with sufficient certainty to be of practical utility, in all cases where the safety of transporting any load upon ice might be jeoparded.

The ice was drilled through, and its thickness measured, to a tenth of an inch, at intervals of two hundred paces and less, along the whole extent of the track. From the place of departure, to the channel of the river, the thickness diminished from 16.5 in. down to 8 in., and no signs of cracking or bending were observed in the ice—the horses going at the rate of about four miles an hour. Across the channel, the thickness increased from eight inches to twelve inches, and no evidence of breaking or bending was exhibited,—the load moving with a speed of about eight miles an hour. From the west edge of Cold Spring flats, to the vicinity of the entrance of a creek, the thickness varied from 12 inches up to 15.5 inches, and no indications of yielding were perceived, the horses going at a gentle trot. Near the entrance of the creek, for an extent of fifty paces, the average thickness of the ice was only 5.56 in., and it was covered with a sheet of snow water, two inches in depth. This fifty paces of ice was observed to bend so much under the gun, that I was very apprehensive of its breaking; indeed, had the load been stopped for a few seconds only, it undoubtedly would have gone to the bottom. The depression along here was at least two inches, and the flexure of the ice under the foremost of the sleds, bearing the gun, was less than that under the hindmost, owing to its being weakened by the former, ere the latter came upon it. On crossing this weak spot, the horses had become so much fatigued, and the resistance increasing, by being drawn up the inclined surface of the bending ice, that, with much whipping and shouting, they were barely urged to drag the gun safely over, at a velocity of about four miles an hour.

To determine the pressure sustained by

a given superfices of the ice under consideration, it is to be remarked, first, that, from the dimensions of the bottom surfaces of the four sled runners under the gun, the whole surface of ice in contact with these bottom surfaces, at the same time, was 6.458 square feet. 2d, That the weight of the gun is marked 5579 lbs., and the sleds supporting it, together with the timbers, lashing chains, wedges, blocks, &c., weighed, in all, 1624 lbs., one sled weighing as much as the other. 3d. That the horses and their sled were so far in advance, the pressure arising from this cause may be neglected, inasmuch as it did not act at the same time, and upon the sane ice, with that arising from the gun.

Therefore, the whole pressure sustained by the 6.458 square feet of ice, at the same time, was equal to 5579 + 1624 lbs., or equal to 7203 lbs.; and admitting, what was very nearly the truth, that the pressure was distributed uniformly, and dividing 7203 by 6.458, we shall have 1115.361 lbs., for the pressure sustained by each square foot; at all events, 1115.361 lbs. will be the *average* pressure sustained by a square foot of the ice.

From the observed effects upon the fifty paces of ice at the entrance of the creek, one can form a pretty accurate estimate of the *least* thickness upon which we can *safely* bring a pressure (of 1115.361 + 10) equal to 1125.361 lbs., (the ten additional pounds being the allowance for the covering sheet of water.) It is evident that the ice will *not be safe*, if its thickness be not above 5.56 inches.

From the foregoing facts, which were obtained with the greatest care, it may be inferred, 1st, That a load may be transported with perfect safety over sound ice, eight inches in thickness, by distributing the entire weight of the system, so that each square foot (in contact with the bottom surfaces of the runners) shall experience a pressure of not more than about 1115 lbs. 2d. That a load *cannot be safely* transported over sound ice, 5.56 in. thick, when the weight is so distributed, that each square foot of surface (in contact with the bottoms of the runners) shall experience a pressure so great as about 1125 lbs.

From the same.

Description of a successful Experiment, with the Heated Air Blast, made at the Oxford Iron Furnace, New-Jersey.

During a recent visit to Oxford Furnace, in Warren county, New-Jersey, on some observations connected with the mineralogy of that neighborhood, my attention was drawn to an arrangement for applying the *hot blast*, which much interested me, on account of the economical simplicity of its construction, and the encouraging results obtained through it.

Upon expressing a wish to make public through the Journal of the Franklin Institute, this first successful experiment of the kind in our country, I was furnished by Mr. Henry, the enterprising conductor of the furnace, with a detailed description of the whole attempt. In a spirit of liberality worthy of all praise and imitation, he placed in my hands all his memoranda, exposing the history of the comparative efficacy of the hot and cold blast at this furnace, and, furthermore, gave me possession of drawings of a new and improved form of the apparatus for heating, which he is now constructing, to be put into operation when the furnace again goes into blast.

In the hope that the brief account which I have to offer, may prove of some service in promoting the introduction of that which is confessedly the greatest of modern improvements in the important art of smelting iron, I beg leave to state the comparative trials of the two species of blast at this furnace, in the order in which the furnace was worked, the better to make their relative effects understood.

It should be borne in mind that this experiment, as far as it has yet proceeded, professes to be merely a preliminary attempt, introductory to a more permanent arrangement, hereafter to be adopted; and it is felt to be defective, therefore, in several points. For example, the *temperature* of the air used in the blast was found to be quite too low to insure that full result which the mode of apparatus employed is supposed capable of yielding. The experiment was imperfect, moreover, from the absence of any precise instrumental observations to ascertain exactly what the temperature of the air was.

To make more intelligible the amount of benefit derived from the heated blast, it seems proper to furnish a brief statement of the capacity of the furnace, and its operation when under the cold blast.

Oxford Furnace passed into the hands of its present enterprising masters, Henry Jordan & Co., in 1832, and was worked during that and the two succeeding years, on the ordinary plan, with cold air. The partial experiment with heated air was made during the months of June and July, of the present year, 1835.

The height of the furnace stack, from the tunnel head to the bottom stone, was, at first, 33½ feet, but was afterwards, in 1834, reduced to 31½ feet; the height of the hearth

Fig. 1.

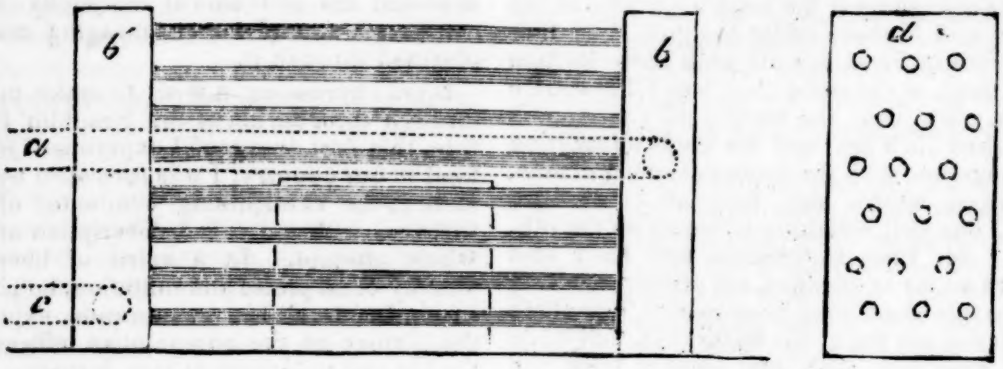
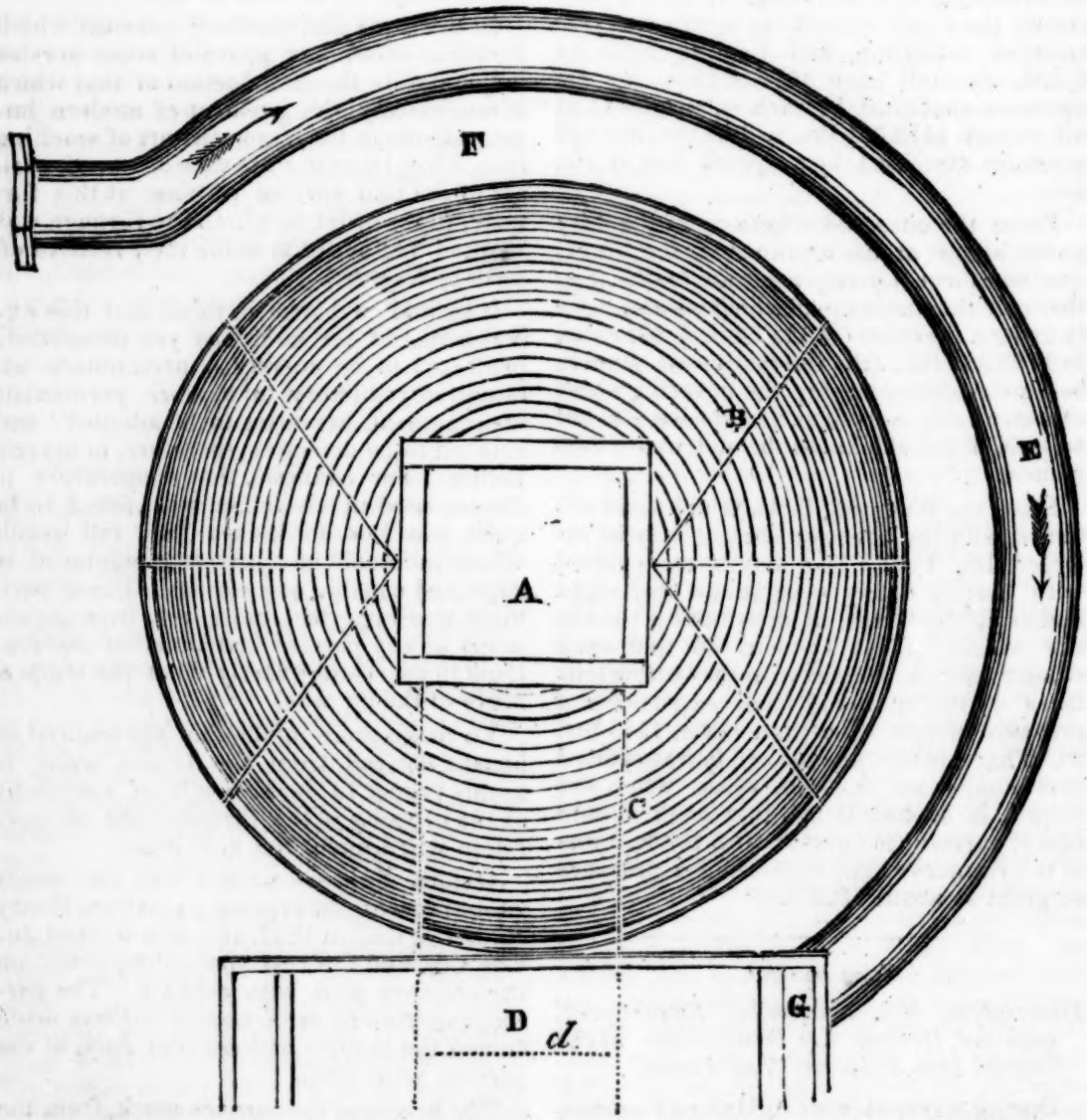
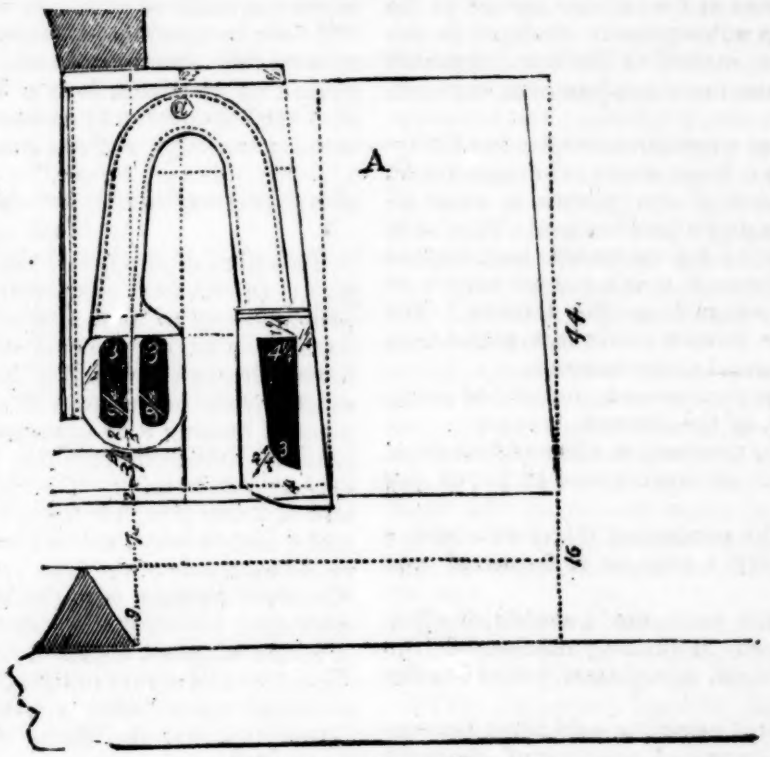


Fig. 2.



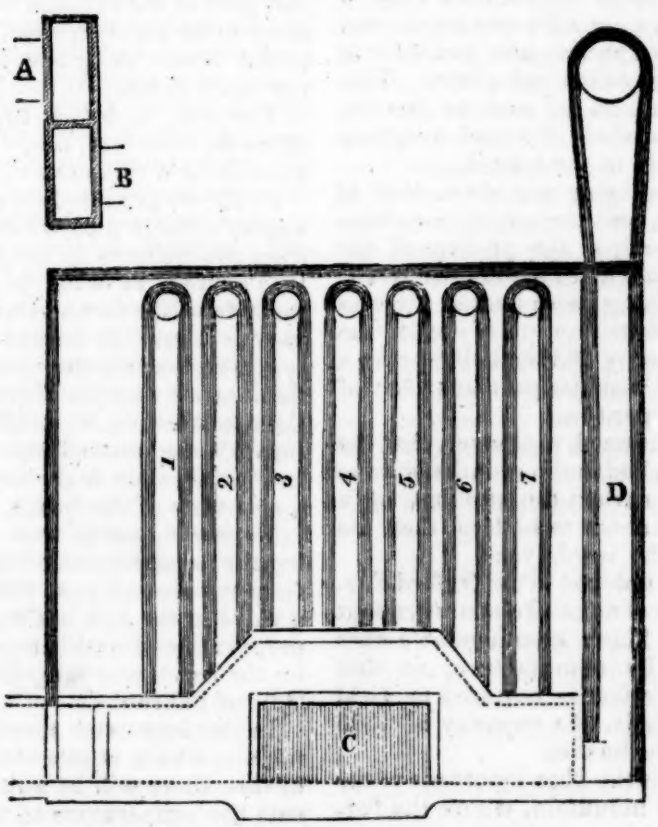
A, Oxford Furnace—hearth 20 by 22 inches; B, incline of boshes—9 inches to the foot; C, hearth line; D, position of the heating apparatus; E, hot air pipe; F, inwall; G, exit; *d*, line dam stone.

Fig. 3.



A, main tempayne; *a*, 2*t*.

Fig. 4.



A, exit; B, entrance; C, false tempayne; D, air pipe.

to the boshes is five feet; the inclination of the boshes was at first eleven inches to the foot, and was subsequently changed to ten and a quarter inches to the foot, at which it stood during the employment of the heated air.

In the more complete arrangement for applying the hot blast, about to be introduced, the inclination of the boshes is to be altered to nine and a half inches. This is in consequence of the increased temperature within the furnace making it necessary to give more support to the burden. The width on the boshes is six feet six inches, and in the tunnel sixteen inches.

With these dimensions, the rate of working, or yield, of the furnace, was,—

In 1832, for nineteen weeks and four days, 327¼ tons, or an average of 16.7 tons per week.

In 1833, the product of thirty-two and a half weeks, 638.1 tons, or 19.6 tons of iron per week.

During this year, the quantity of charcoal consumed in making one ton of iron was 243 bushels, of eighteen pounds to the bushel.

In 1834, still using the cold blast, but employing an improved quantity of charcoal, the product, for twenty weeks and five days, was 240.4 tons. or, 11.6 tons per week.

So low a product was due to the hard and refractory character of the ore then used.—It was taken from a considerable depth. was very compact, and a portion of it yielded iron having the qulity called red short. This year, the consumption of coal to the ton of iron, was 226 bushels of a coal weighing twenty-two pounds to the bushel.

In 1835, the coal being similar to that of the previous year, and the ore of its ordinary much better quality, the product of the iron was at the rate of 18.9 tons per week.

While the smelting with heated air was in progress, the consumption of coal to the ton of iron was only 165 bushels, being a saving, compared with the previous year, of sixty-one bushels per ton.

It should be mentioned, moreover, that the new blast was applied in the months of June and July, a season when the product of a furnace is well known to be less than its average rate for the whole year.

The charcoal employed in the Oxford Furnace, is a mixture of oak and chestnut, about two-thirds oak. Much commendable care is employed in its manufacture, so that a cord of 128 cubic feet is required to yield at least forty bushels, of a capacity of 2353 cubic inches to the bushel.

The flux used is the blue limestone of the vicinity of Scott's mountain, where the furnace is situated.

The ore smelted at this furnace is the magnetic oxide of iron. It is mixed with but little foreign matter, and occurs in veins, several feet wide, in Scott's mountain; it makes an excellent, tough, bar iron, and is also well adapted, and extensively used, for making castings, and pig iron.

Description of the Apparatus for Heating the Blast.

This plan of supplying the furnace with air at an elevated temperature, is upon a principle said to be in use in Germany. It consists in urging the cold air from the bellows, through tubes laid adjacent to the most highly heated part of the furnace, in place of heating it by separate fuel, in an apparatus detached from the furnace. The contrivance is this: Two hollow cast-iron boxes, 2 feet 9 inches high, 15 inches deep, and 8 inches wide, are set into the masonry, on each side of the false tymp, and placed directlyin contact with the main tymp, and with their broadest sides facing each other. A series of tubes, eighteen in number, pass from one box across to the other, and are so arranged immediately above the top of the false tymp, that the flame which plays in front of the main tymp, and under the sow, may pass around them as freely as possible. The interior diameter of the tubes is two inches. Their position in front of the hottest part of the furnace is such as to enable them to be highly heated, as well by the external flame, as by the heat radiated from the main tymp.

The air, in being urged through thees tubes is, therefore, made to acquire a very considerable elevation of temperature.

In the diagram before us, fig. 1, *a* represents the large pipe which brings the blast from the bellows to the heating apparatus. It is curved, in order to pass round from the side of the furnace where the tuyere is, to the front. It passes close to the main tymp, and enters the remote box, *b*. From this the air escapes through the tubes into the opposite box, *b'*, and finds its exit thence through the curved pipe, *c*, which leads it in a heated state to the tuyere; *d* represents a side view of the boxes, *b*, *b'*.

No arrangement was made for measuring the temperature of the air, as it issued from the second box, farther than adapting a valve in the side of the pipe, *c*. The temperpture, estimated there by the sensation on the hand, was judged to have been about 200° of Fahrenheit.

In the improved mechanism for heating the air, which is intended to tako the place of this, there will be a thermometer to indicate the temperature of the passing air precisely.

At the same time that the apparatus here described was erected, a modification in the false tymp was made, to keep it cool, and thus prevent that rapid destruction of it, to which it is liable, under the high heat of the front of the furnace. It was designed to achieve this by making it a hollow cast-iron box, and transmitting through the interior a current of cold water, to enter below, and to issue at top.

The thickness of the iron in the bottom of this hollow false tymp, was two inches at bottom; at the back it was one and a half inches; and in front it was one inch. It was found, however, not to be stout enough beneath, for it soon gave way under the action of the fire.

Imperfect as Mr. Henry admits the above arrangement to have been, he was fully convinced, during the trial, of the useful results to be procured from such a form of apparatus.

Independently of the very considerable saving of sixty-one bushels of the best charcoal to each ton of iron, there was a steadiness in the working of the furnace, and, therefore, a uniformity in the quality of the iron, of no small object in every extensive establishment.

As a consequence of this regularity in the action of the furnace, it was found that the superintendence of the man who managed the tuyere could almost be dispensed with; so much so, that even after casting, during which the blast is usually taken off, no scraping of the tuyere was necessary to detach the congealed cinder which commonly adheres, proving how much higher the temperature of the furnace remains, when the heated air is employed. It would seem, indeed, that weather and season have little or no effect in deranging the working of a furnace driven by the hot blast.

It remains to describe concisely the other form of the apparatus for heating the air, which Mr. Henry is now constructing.

The object of this, which is upon the same principle as the first, but considerably modified and improved, is to procure a higher temperature in the blast, and, at the same time, to preserve the desired coolness in the false tymp, by passing the *blast* through it, in substitution of the water before employed. The false tymp is, therefore, hollow, and forms a part of the chain of connection through which the air from the bellows is made to circulate.

Fig. 2 shows the position of the semicircular pipe, which leads the cold air from the bellows, round the stack, to the side of the main tymp; here the pipe descends to enter the side of the false tymp, an end view of which is seen in fig. 3.

In fig. 3, a profile, or side view, is presented, of the manner in which the air is conveyed, from the interior of the false tymp, through a series of cyphon-shaped pipes, into the front chamber of a box, which lies in front of, and parallel to, the false tymp.

This box is divided by a partition into two chambers, an opening at one end of the partition permitting the air received into the front chamber from the pipes, to pass behind into the other; from this it issues through a large pipe, which curves round the angle of the furnace, and conveys the air to the tuyere.

Fig. 4 represents a front view of the anterior box, and the air pipes, seven in number, which connect it with the false tymp in the rear. The doorway in the middle of this front box is designed to permit the flame and heated air which play up near the dam stone, to pass between and envelope the pipes, previous to escaping under the sow.

The whole is of cast-iron, the lower part of the walls of the hollow false tymp being at least four inches thick.

In the pipe which leads the air, heated by traversing the tymp, the tubes, and the two chambers of the front box, from the latter to the tuyere of the furnace, there will be a contrivance placed to receive a mercurial thermometer. It will consist of a tube of copper, of about one inch diameter, and six inches length, closed at one end, and the closed end inserted three or four inches through the side of the pipe, so as to expose it to the current of heated air which passes along the pipe, and which will impart its own temperature to it. This tube will be filled to a small height with quicksilver, and the thermometer bulb made to dip into the mercury. The scale of the thermometer will, of course, project out of the tube, that the temperature recorded upon it may be seen.

Mr. Henry intends keeping a daily register of temperature of the blast, and the state of the furnace. Such a register will be highly interesting, and we wish every success to the ingenuity of the liberal and enterprising masters of the Oxford Furnace.

From the London Mechanics' Magazine.

PRINCIPLES OF RAILWAY LOCOMOTION.

Sir,—The writers on dynamics have demonstrated, that the force just necessary to prevent a heavy body from rolling down a smooth inclined plane (abstracting friction) is $\frac{ah}{L}$, where a is the weight of the body, h the anheight of the plane, d L its length.

This theorem is universally true, whether as respects our earth or any other of the celestial bodies. But in determining the space, time, velocity, &c., in and with which a body moves down an inclined plane, or when projected up a plane, it has hitherto been found absolutely necessary first to ascertain experimentally the value of the symbol g, which means the measure of the force of gravity or the velocity a body has acquired at the end of the first second, the motions commencing from a state of rest, and the direction being in a vertical line; and from thousands of experiments, the value of g in our latitude has been found to be $32\frac{1}{6}$ feet. I observe, however, in No. 618, your scientific correspondent, Mr. Herapath, has attempted, without the aid of g, to give us some very important formulæ on the principles of Railway Locomotion; I say important, if they shall turn out to be true; but on this point I must confess that I have some misgivings.

Mr. Herapath says, "that he has determined three rules as simple and correct as he believes it is possible, in the present state of our knowledge, to make them." Then follow the three formulæ (see p. 182, col. 2, and 183, col. 1). Mr. H. himself, however, seems a little puzzled at the result of the expression $\frac{30}{1 \pm \frac{h}{22,}}$ which represents the speed in miles per hour when the load is moving up or down the plane. For, as he truly observes, "we can hardly apply this formulæ to descents unless they be very small; for if the descent was 22 feet per mile, it would make the velocity appear to be infinite," &c. No doubt the formula produces such a result; and it is rather surprising that when Mr. H. found this was the result, he did not take it as a warning that there might peradventure be something wrong in his formula. An infinite velocity is no joke, and, perhaps, might be attended with *some* danger. Let us assume $h=21\frac{1}{2}$ feet (and on this supposition gravity will not do all the work); the velocity in this case will be 1,290 miles per hour (quick enough, no doubt, for any *ordinary* purpose). Again, by assuming $h=22\frac{1}{2}$, the velocity will turn out to be negative at the rate of 1,320 miles per hour. A negative speed, although perfectly understood by algebraists, may, to some of our readers, who do not rank as such, require some kind of explanation. For their benefit, here it is. The carriage and load, instead of moving down the plane, as might be expected (as gravity in this case does something more than the whole work), will, to the utter surprise of every one, roll up the plane at the rate of 1,320 miles per hour!

Perhaps, however, Mr. A. meant that when h is greater than 22, the formula assumes the form $\frac{30}{\frac{h}{22}} 1$. But upon trial, this change will not much mend the matter. I am afraid the formula will not be exactly true, except in the case when $h=o$. Mr. H., it is true, may say that the resistance of the air will prevent any thing like a velocity of 1,290 miles per hour. No doubt, if we had 30 square feet of opposing surface, and when the resistance of the air approaches "nearly to 344 horses' power," it would certainly be a very great check upon the velocity. Again, Mr. H. may state that he has premised that the value of h must be very small; I know he has said so, but in answer to this I beg to state, that he has not given the greatest limit to h, so that we may know when his formula presents a true or a false result. With respect to this formula, as it regards ascending planes, although it does not present such seeming absurdities, still, being derived from the same suspicious source, no faith can be placed in its accuracy.

I am well aware, Mr. Editor, that Mr. H. is considered by many to be both a mathematician and a philosopher of the first order; I well recollect the challenge he gave to the Royal Society on some physicla question, backed by a wager of 1;*l*.000 still. notwithstanding all this, I maintain that his algebraical formulæ on Railway locomotion, are not founded upon true principles.

I am, sir, yours, &c.

IVER MACIVER.

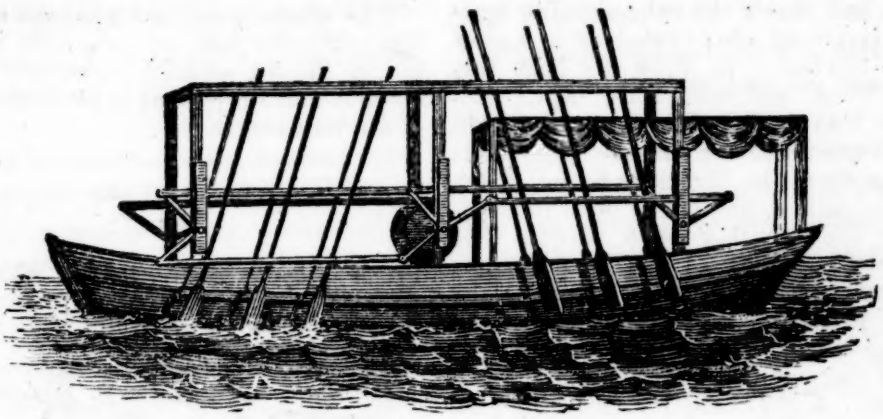
June 20, 1835.

P. S.—I am much obliged to Kinclaven for the correction he has made in my last article; the only recompense I promise him will be, if he should ever fall into a like mistake, I shall endeavor to set him right.

I. M.

We are indebted to N. SARGEANT, Esq., Editor of the Philadelphia "Herald," for the following cut and description of the "first steamboat." It opens anew the question as to whom belongs the credit of first applying, or attempting to apply, steam to navigation.

THE FIRST STEAMBOAT.—The honor of having originated the application of steam power to propelling vessels has been so gen-

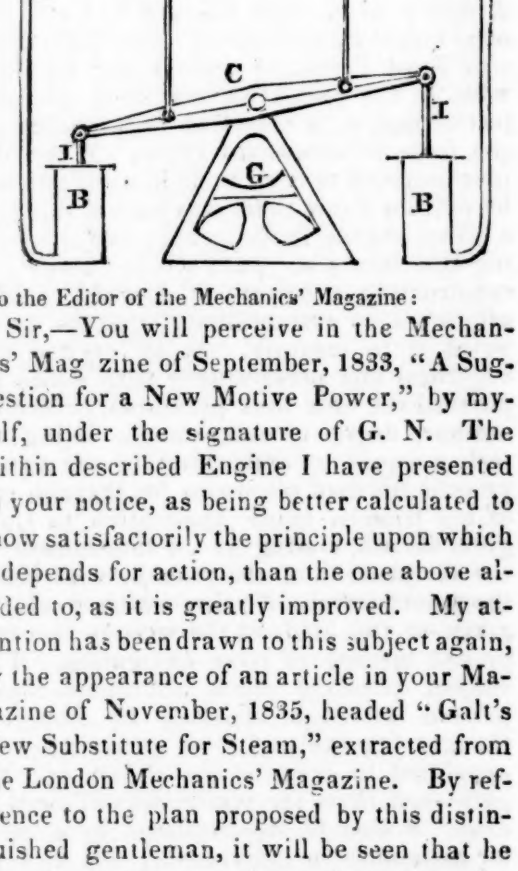


erally awarded to FULTON, that any attempt at this day to transfer his laurels to another may seem equally unseasonable and hopeless. Yet it is a fact known to many of our citizens, that twenty years before the great experiment of Fulton and Livingston on the Hudson, a steamboat had been constructed in this city, under the sole direction of a then obscure and still almost unknown individual. This individual was JOHN FITCH, by trade a watchmaker, who, in the year 1785, conceived the project of making a vessel to be propelled by the force of condensed vapor. When the idea occurred to him, as he himself tells us, he did not know there was such a thing as a steam engine in existence; and his having entertained so vast a scheme, as that of constructing a steamboat, seemed to him afterward so extraordinary, that he attributed it to insanity. At all events, the eagerness and perseverance with which he pursued the idea thus presented, evince no ordinary degree of enthusiasm. Being utterly unequal to embarking in the enterprise on his own resources, he, through one of his friends, made application to Congress for aid, stating as an inducement to the furtherance of the plan by that body, the great increase of value which would be given to the lands at the west by this improved method of river navigation. The subject attracted much attention—many persons of high standing in Congress thought favorably of it—a committee was appointed to examine the papers and report—and there the matter was allowed to drop. Foiled in this attempt, he applied for assistance to individuals; but at first, with no better success. Those who had intelligence to comprehend and means to aid his scheme, were cautious of embarking in a new enterprise which it was evident must involve heavy expense, and the result of which appeared so uncertain. In 1786 he communicated his ideas to Voight, an ingenious mechanic, who cordially approved his plan, and promised every assistance. Between June and August of this year he constructed a model, which worked to his entire satisfaction. By unwearied exertion he at length succeeded in interesting about twenty persons in his plan, and inducing them to take shares of 50 dollars each. Even this was paid very reluctantly, and he found himself obliged to make application to the State Legislature for further aid. A letter which he wrote on this subject to Gen. Mifflin, shows how sanguine were his anticipations of the results he should obtain. He reckons confidently on a speed of seven or eight miles an hour, and on being able to navigate the sea as well as rivers with his new invention. His application however failed, and he found himself greatly embarrassed by want of the requisite funds, at the same time that he was regarded by the company as pledged to persevere in his enterprise. The works were commenced in May, 1787, and completed during the summer. It was found, however, in addition to failures in smaller parts, that the power of the engine was inadequate to propel the boat, and that it was necessary to construct a larger cylinder. A second application was made to Congress for aid, but failed. The cylinder, when made, proved imperfect, and it was concluded to try the old one in a boat of smaller size. In 1788, the boat made a trip from Philadelphia to Burlington; but on her arrival there, when success seemed to have crowned his exertions, the boiler sprung a leak, and became useless. The boat was towed back, repaired, and again commenced running. In October, a passage was made to Burlington in three hours and ten minutes, and others at nearly the same rate. Still, on the whole nothing was gained on the rate of land travel, and in this respect the result was a failure. In June, 1789, a larger cylinder was tried, but still without much improvement in speed. In disgust, Fitch abandoned the management of the

concern, and threw the responsibility upon Voight, retaining only the place of assistant and adviser. In 1790 the boat was again altered, and the 12th of April another trial was made. She performed well, and the business of the summer was tolerably prosperous. In the mean while, Fitch was principally engrossed in legal proceedings for the securing of a patent. His claims were contested by Rumsey, who maintained that to himself belonged the honor of priority in applying steam to the propelling of boats. What were the real merits of Rumsey, we shall not undertake to determine. A boat constructed on his plan was tried in London, and failed. Fitch gained his patent, but it was never attended with any pecuniary advantage. The company continued together another year; but with so little profit, that in April, 1791, a meeting was held, and a proposal made to abandon the enterprise. Others, still sanguine, were in favor of another trial, with a new boat, and improved machinery. This project, however, was not executed. The last struggles of the PERSEVERANCE terminated in the year just named, and she was consigned to a neglected old age in Kensington docks. Fitch died, under great pecuniary embarrassment, in 1793. He had filled several small MS. books with personal and general narrative more or less connected with his great scheme, which he bequeathed to the Philadelphia Library, with the proviso that they were to remain closed for thirty years. He seems to have been determined that one generation should pass before he again submitted his reputation to the tribunal of human opinion. The books, which were opened in due time, contain a minute account of his perplexities and disappointments, written in a manner which shows that these had not left his temper unruffled, or inspired him with very kindly feelings towards mankind. There are interspersed in the narratives many shrewd remarks, and even humorous sallies, but their general tone is desponding and querulous. His mind, naturally strong and original, seems to have received from the circumstances in which he was placed an unhappy bias; and the tone of expression in which he appears to have indulged, must of itself have been an obstacle to his success. Of the boldness of his conception, and the perseverance with which he followed it up, there can be but one opinion; and had fortune seconded his efforts, and his means been equal to the accomplishment of his designs, there can be no doubt that he would now hold undisputed the honor of having given to the country this most noble and useful invention.

The above wood cut conveys a correct idea of Fitch's boat, as originally planned; but in the one actually constructed, he so far modified this plan as to place the paddles of the boat astern.

"NOBLE'S AMERICAN HYDRO-PNEUMATIC ENGINE."



To the Editor of the Mechanics' Magazine:

Sir,—You will perceive in the Mechanics' Mag zine of September, 1833, "A Suggestion for a New Motive Power," by myself, under the signature of G. N. The within described Engine I have presented to your notice, as being better calculated to show satisfactorily the principle upon which it depends for action, than the one above alluded to, as it is greatly improved. My attention has been drawn to this subject again, by the appearance of an article in your Magazine of November, 1835, headed "Galt's New Substitute for Steam," extracted from the London Mechanics' Magazine. By reference to the plan proposed by this distinguished gentleman, it will be seen that he intends elevating a piston, by means of a Bramah's press properly applied to force water under it; then, by discharging the water from below, to cause it to descend, and by these means to acquire a motion and power as effectual and universal in its application as steam, without its danger

of explosion. The question naturally occurs to a person examining the plan, "How is the press to be worked?" Undoubtedly by some auxiliary power, as steam, or by hand. If such is the case, (and that it is the article implies,) it should be recollected "*that whatever force is applied at one point can only be exerted at another, diminished by friction and other incidental causes;*" and also, "*that whatever is gained by the rapidity of execution, is compensated by the necessity of exerting additional force.*" The power, then, of the Engine is just equal to the force necessary to actuate the press, "*diminished by friction and other incidental causes.*" Hence, if the power of one man is sufficient to work the press, and consequently the Engine, it will be found that (supposing it applied to navigation) the man would move the boat with a greater velocity if he worked directly upon the oars or paddles. Now it will be seen that in the "American Hydro-pneumatic Engine" the necessity of a press is superseded, by continuing a pipe subjoined to the bottom of the cylinder perpendicularly upwards, and substituting the pressure of a column of water for the piston of the press. This pressure is, in its turn, suspended for a time by a pre-existent cause, which is put in action without a direct application of force. An engine might be worked with water by means of vertical pipes subjoined to a cylinder containing a piston, and the piston would be elevated with a force proportionable to its perpendicular height of pipe. If the water be now discharged from below the piston, and the supply obstructed, it will descend by its own gravity and the pressure of the atmosphere above—a vacuum being formed below by the discharge of the water. But the upward motion of the piston will be the most powerful. Now if a cylinder and piston be attached to each extremity of a working beam, the one will be exerting its maximum, while the other is exerting its minimum force, and the motion will be equalized. It is probable this method of using water where the fall is great and the supply small, is the most advantageous.

In the "American Hydro-pneumatic Engine" the same water is used continually, without any additional supply, except what is necessary to compensate for loss by evaporation.

References.—BB are two strong cast-iron cylinders, similar to those of a steam engine, but open at the top, containing pistons, fitted and packed in the usual manner with piston-rods. C, a working-beam, attached by fixtures for preserving a parallel motion to the piston-rods at each extremity. G, gallows-frame, for the support of the working-beam. DD, two balance wheels, moved by the shackle-bars EE, by the cranks HH. FF, are two pipes subjoined to the bottom of the cylinders, and continuing perpendicularly upwards, to any height not exceeding 32 feet. AA, are two air-tight chambers, attached to the top of the vertical pipes. There are slides or valves in the chambers, by which they can be made air-tight, or opened at the proper time. Also pipes for the conveyance of carburetted hydrogen gas, communicating with an iron retort or generator of gas. The slides for admitting and excluding the air, and apparatus for admitting and igniting the gas, and also the parallel motion, are not represented in the drawing. The drawing and description above is thought sufficiently simple to be well understood, without any additional trouble to your engraver, as the machinery for effecting the changes in different stages of the action is so simple as to suggest itself very naturally to any one.

We come now to the manner of putting it in operation. Water, or any other fluid, may be employed. The pipes and cylinders being filled, let the jet of gas in one of the chambers be fired, and the valves of the chamber closed, rendering it air-tight. The combustion of the gas produces a vacuum, raises the fluid in the pipes from beneath the piston, and allows the other piston to raise by the pressure of the column of fluid in the other pipe. The vacuum is now destroyed by opening a communication with the external air, and the vacuum being produced in the other chamber, the water

returns to its original position, elevating the piston. Thus, a regular reciprocating motion is obtained, with a force equally applicable to driving all kinds of machinery with steam, with none of its danger. And the expense of working is comparatively small, nothing being requisite but a small fire for heating the retort.

It will also be seen that there is a limit to the size, and consequently power, of this Engine, as the pipe for raising the fluid employed cannot exceed 32 feet in height where water is used, and so in proportion to the density of the fluid mercury, oils, and other fluids may be made use of. And again, considerable difference may be made in the motion of this Engine by the comparative size of the pipe and cylinder. Where the pipe is small with reference to the area of the piston, the motion will be slow, with a great effective force, and the velocity will be greater where the pipe is larger, with less force. In the fast motion a greater quantity of the gas is consumed in a short time, and it is probable the same quantity is consumed in a longer time in a slow motion. Thus far I have endeavored to show, in my humble way, the *principle* upon which my "Hydro-pneumatic Engine" depends for its action. As before stated, I know not what Mr. Galt proposes, any more than is contained in the article in your last. But lest he should have hit upon my plan, I have published this, and shall claim the priority of invention, as I exhibited drawings of this nearly five years ago. It is a fact worthy of notice, that many important inventions of American origin have been brought out in England as original. Your talented correspondent, RUFUS PORTER, makes mention of one case, in the Rifle with a revolving breech—and there are many others.

The Aeranautical Steam Car published by your correspondent, Rufus Porter, is indeed very similar to the one proposed by me, and the coincidence is somewhat remarkable: it appears that both communications were received at the same time But it was unnecessary for Mr. Porter to have supposed that the public would have thought he had taken any thing from mine, as his communications to this Magazine are of such a nature as to convince any person that he is a man of different stamp.

BUTLER G. NOBLE.

Dexter, N. Y., Dec. 17th, 1835.

The most remarkable result of barometrical measurement was recently obtained, by Baron Von Humboldt, showing that about 18,000 square leagues of the northwest of Asia, including the Caspian Sea and the Lake of Aral, are more than 320 feet below the level of the surface of the ocean in a state of mean aquilibrium. This enormous basin is similar to some of those large cavities on the surface of the moon, and is attributed by Humboldt to the upheaving of the surrounding mountain chains of the Himalaya, of Knen-Lun, of Thion Chan, to those of Armenia, of Etzerum, and of Caucarus, which, by the undermining of the country to so great an extent, caused it to settle below the usual level of the sea. The very contemplation of the destruction which would ensue from the bursting of any of those barries which now shut out the sea, is fearful.—[Mrs. Somerville.]

From the London Mechanics' Magazine.

SELECT COMMITTEE OF THE HOUSE OF COMMONS ON ARTS AND MANUFACTURES.

MINUTES OF EVIDENCE.

Mr. John Jobson Smith, of the firm of Steward, Smith, and Company, Iron Founders, Sheffield, examined:—

What branch of manufacture do you particularly pursue?—Iron foundry, applied to ornaments.

Have you occasion to have models made to a great extent?—We expend about 1,500*l.* a year in the production of models of this kind for stoves and fenders alone.

[*The witness produced a model of a stove front.*]

Are your models, some of them, very beautiful?—They are very beautiful.

Has Sir Francis Chantrey expressed any opinion upon them?—Sir Francis Chantrey has seen some of them, which he said were the finest specimens of iron manufacture which he had seen in the kingdom.

In those works of art, how far is the inventor protected?—There is no protection at all; we have sent out such a thing as

that on Monday morning, and it has been to Manchester, back again to Sheffield, and copied and returned to Manchester before Saturday night. The model which I am now speaking of cost us 50*l.* for men's labor.

Is the copy as good as your original work?—It is not; but they sell them so much cheaper, because they pay nothing for the production.

This, of course, is great injustice, and serious loss to the persons that invent the designs?—It is so great a loss, that we shall give up continuing it; I suppose that more than one-half of the patterns for stove-grates and fenders used in England have originated with us, but the piracy has come to such an extent, that unless there is some protection we must give it up altogether.

What would you suggest as a protection?—I should suggest some place, such as the National Gallery or Somerset House, where those things should be registered and some mark put upon it, such as the royal cipher or crown, denoting the registry, and a protection given for a certain time, three years, perhaps.

Are you aware of the system by which patterns are protected in France?—I am not aware.

In the manufacturing towns of France there is a body consisting of one-half workmen and one-half masters, and to them the preservation of the patterns is confided by the law; the pattern is examined by this body, whose knowledge of the manufacture is sufficient to ascertain that it is original; the right of the presenter of it is recorded, with a given date, a small sum is paid for a protection for a certain number of years, and that record and the preservation of the pattern which is deposited in the hands of this body, enables him at once to enter legal proceedings against any pirater of the patent; do you think any such system of protection could be brought to bear in England, or can you suggest any better system of protection than that?—I should almost fancy that it would be impracticable in this country, because there is not such a location of the casting of iron.

Do you think a central board would answer the purpose?—I should think the object might be effected by a central board, where an actual cast of the original model might be deposited and registered, and left there a certain time for examination as to its originality, and the fact of its being registered might be proof of its originality after a certain time.

Would not the great difficulty be, that the persons who purloined patterns are ordinarily very inferior men, who could hardly repay the damage they have done?—It is not the case in articles of this kind, because there must be a considerable capital invested in the manufacture to produce it.

You think if you could verify the fact of your being the inventor, there would not be much difficulty in inflicting the penalty?—I think not.

You think it would not be worth the while of the inventor to go to the trouble and expense of registering unless the invention was worth protection?—No.

What are the class of artists that you employ for the production of patterns?—Some artists in London have been employed to make patterns for this description of goods. The young man that made this which I have produced has had no education in the art; he has studied from nature altogether, and this is a specimen of his production; he has risen so as to have the reputation of being the first in the trade.

Is he a person of considerable natural talent?—So much so that we have given him a share in the business on account of his natural talent.

Are those models drawn upon paper?—Yes; and if we were to confine ourselves to publishing them on paper, the law would give us a title to protection for them, but as soon as we bring them out in the form of a manufactured article we lose all right and title.

Are there several artists in Sheffield capable of producing such models as these?—There are several.

Have they increased of late years?—No.

Do they get tolerable wages?—They do not get very good wages, because the manufacturers in the neighborhood so depend upon piracy, that they do not employ them; but if protection were afforded them, each manufacturer would be forced to employ an artist.

You think that if art were better protected in this country, there would be a greater demand for beautiful designs?—There would, because the general taste is so much better than it was, that very superior things are now in demand.

To what do you attribute the improvement in the public taste?—I have sometimes attributed it to the fact of there being

so many fine models in plaster for the external and internal decorations of rooms, by which means they have become better spread.

Do not you think that the opening of our intercourse with the continent has led to a great improvement in the national taste?—It has. French ornaments and French style have become introduced into this country, and become ingrafted into our own style.

Have you been able, notwithstanding the heavy duties upon this species of article, to export any to France?—No; we can send none to France; there have been some smuggled to France.

Do you think that the foreign models are superior or inferior to the English?—In this branch of manufacture I think they are inferior.

Are you aware that grates are not used in France?—They are used in France, I believe; they are porcelain grates very generally.

Are there persons employed at Sheffield to form those designs on paper?—No.

Have you attended to fenders as well as grates?—Yes.

Are the artists employed at Sheffield generally uneducated, or do they undergo some previous education in art?—They have had no education at all; it is a few men of natural talent, who have been accidentally directed to drawing very early, who have followed it up in this way.

Do you know any place in this country where a young man could obtain such knowledge?—No.

Have you a Mechanics' Institution at Sheffield?—We have.

Do not they instruct young men gratuitously in design?—They have got several works of design, but there is no instruction given; those works, however, have been of great service.

Do you think it would be a good thing to extend the means of instruction in design among the people?—Certainly.

And especially to open collections of the best specimens?—Yes.

Have you often heard among artists a wish expressed that the knowledge of art should become more accessible to them?—Yes.

Do you know any class of persons in this country who are capable of teaching that kind of art to which you allude?—I am not aware that there are any except at very great expense.

Have the parties who draw those patterns been instructed at all in drawing?—Not at all.

And the state of the law is such that there is little encouragement to artists?—A capitalist will not purchase the higher order of talent, because no sooner does he produce it than it is stolen from him.

What can an artist obtain per week by devoting his time to the production of models, in Sheffield?—About 3*l.* or 4*l.* if he is a clever man.

It is then the best paid labor?—It is.

How many artists do you suppose in Sheffield are solely employed in producing models?—Not above four.

Have they been all successful?—One of them has not been very successful.

Do not you think the public taste is so much improved that encouragement would be found for the production of articles more and more beautiful?—We find that we cannot produce articles too expensive for the public taste of the present day. Could we employ artists of a higher character, I am satisfied that the public would buy whatever was produced.

You think that cost would be no barrier to the sale of beautiful articles of art?—No; I should not myself hesitate in expending 200*l.* or 300*l.* in the production of a model for a grate to-morrow, if I had protection for it; but now it is certain that every thing worth pirating is pirated in three months; many things that are very good are pirated in fourteen days after the time of their production.

As the taste is perpetually varying, how long would you conceive a sufficient protection to a pattern?—I think three years would be the least. The custom of the manufacturers of those things is to visit their correspondents once in six months, and it frequently happens that there is some reason for not having a new thing at the time, and it is frequently a twelvemonth before a pattern comes fairly before the public. I think we should have a fair protection for three years.

Unless you give rather a long period to the protection of a design, is not the effect of it to allow only a man of large capital to reap the advantage from the protection, because he only can put out a sufficint quantity of the pattern to remunerate him-

self?—Yes; every person to produce things of this kind must keep an extensive establishment about him. Besides the payment of the designer and the modeller, there must be workmen who get high wages after they have been designed and modelled.

Would the amount of capital employed in your business depend upon whether you had a protection for two years or three years?—No.

Does what you state apply, not only to your own line, but to all other lines in Sheffield?—Yes.

And more especially to steel and plated goods?—All the articles of plated goods that are stamped.

Have you conversed with persons whom you think most capable of judging of the propriety of legislative measures to protect such inventions?—I have.

Is the plan you have suggested of a central board the result of your inquiries among them?—It was my own opinion. I have not spoken to others respecting the details of the protection, but only generally; and I have the authority of Sir Francis Chantery to say, that he decidedly coincides in my views, and he thinks that it is most desirable that something should be done for the protection of arts of design.

Do you consider that the suggestion you have made would be practicable without interfering with the general convenience of manufacturers throughout the kingdom?—There is a certain class of manufacturers whose convenience it would most materially interfere with, in the same way that the police interfere with the practices of certain men.

You say that you think you ought to have it for three years; by what means could the numerous manufacturers of similar articles throughout the kingdom know when the period had expired?—I would say, that upon each article registered there should be a royal cypher and a crown cast, and a penalty should be attached to the casting that without a register, and there should be a penalty attached to casting it after the period of protection had expired, so that the public would know what articles were under the protection.

Suppose you put a crown upon an article on the 27th of July; how could a man that makes similar articles in Scotland, upon seeing one of those grates, discover from it whether your protection commenced in 1835 or 1837?—There would be the central register here, which should be open to the public, and he might obtain a drawing of any particular design by applying to the Register-office, and if it was worth his while to make it, it would certrinly be worth his while to apply for a drawing of it; but if it was necessary, the date might be put upon most things; upon a large article it might be done with the greatest facility, but there are many things so small, that we could hardly put the date upon it; for instance, an ornament that would have to be cast in the sand.

Do not you think, that if there was not the facility of copying that now exists, any new invention would be more slowly promulgated through the people?—We visit every town in England twice a year, and therefore the whole country has an opportunity of having those things if they please. The fact is, that instead of each house making designs for itself, or each employing an artist competing with the artist of another house, there are not above two or three now producing models for the whole of the kingdom.

Do you think it would be possible to effect the object in this way, by allowing the inventor to permit other persons to use the invention upon payment of a certain sum to himself?—I do not think that could be done. I think men would be more disposed to produce their own, than to live upon the reputation of their neighbors.

Is not there great difficulty in discovering what is a distinct pattern, and what is only a variation from a previous pattern?—There is the greatest difficulty there; but I think persons would not be willing to produce a pattern that was doubtful as to its originality.

Do not a great number of ornaments consist of a combination of old materials, and is it not likely that any other individual might combine these materials in a manner so similar as to make it difficult to know whether he had the object of piracy in view, or whether the similarity was not casual?—There would be so much of the particular mind and style of the artist, as to fairly constitute an original.

Is not this particular grate now before the Committee a combination of common ornament?—There has never been any thing approaching this before.

Unless it were so distinct, would it be

worth your while to pay so much to your designer for it?—Certainly not.

Mr. John Martin examined:

You are well known as the painter of many eminent works: in your early professional education, had you occasion to acquire a knowledge of those manufactures that depend somewhat on the arts?—Yes.

State what branch you became acquainted with?—That of coach-painting.

What information can you give us on this portion of the subject?—I fear very little; only with regard to art there is great deficiency in drawing and coloring, as we know by the works on coach panels, but there is capability of a great deal of improvement, with the assistance of schools, or rather museums.

It would give, you think, a greater development to art?—Supposing, at museums, such as the British Museum, there were professors capable of instructing; I mean for the study of the human figure, lanscape painting, architecture, and every other useful branch.

Have you pursued any other branch of manufacture connected with the arts?—China-painting; when I first came to London it was just going out of fashion, for it depends on fashion when not sufficiently advanced by the assistance of art.

What do you think of the state of art in regard to china-painting?—It is very low indeed, in consequence of the deficient knowledge in drawing and the arts in geeral; I believe it has gone down considerably since Mr. Muss and Mr. Marsh (who was a very eminent flower-painter at that time) left it.

Do you suppose that instruction is required for the artist in china-painting?—Yes, a knowledge of drawing is decidedly necessary; it was their knowledge of drawing, &c. that made Mr. Muss and Mr. Marsh so superior to others; but owing to the decline of china-painting they were compelled to leave it; and it has since entirely gone to the ground.

When you speak of painting in china, do you include in that enamel-painting?—Painting on china is a sort of enamel-painting, but that which is generally understood by enamel-painting is the style in which Mr. Bone and Mr. Muss attained such pre-eminence; that it is strange that so splendid and truly national a collection as Mr. Bone's "Eminent characters of the Elizabethan age," should not long ere this have been lodged in the British Museum or National Gallery.

Have you turned your attention to the difference or the relative state of china painting in France and England?—I have seen some French painting on china, and upon the whole I think the finish is much higher.

Do they draw better?—Yes; the French are better draughtsmen, almost in every thing; I suppose they have a better opportunity of learning; besides it is patronised by Government.

You think for china-painting that instruction in correctness of design is very much wanted by our artists?—Yes.

For instance, you mean in anatomy, perspective and proportion?—Yes, every branch of art might be obtained in a museum where every one is permitted to go; but there are no professors in the British Museum, and the students can only learn by seeing others draw on the spot from things which are worth drawing; the Elgin marbles, for instance.

Do you not think it desirable that an artist should possess a knowledge of anatomy?—Certainly, for the drawing of the human figure or animals.

Might it not be desirable to give them opportunities of understanding *ab initio*, beginning with the skeleton, and going on to the whole proportion?—Yes.

And the study of the muscles?—Yes, and proportion, which has never been attended to.

Would a young man learn all these, according to this division of labor in the art, merely by a museum?—I think so, by proper masters.

You would have masters?—Yes; masters are necessary to give the proper direction to the pursuits of the student; but one master might teach two or three branches of the art, as follows: one master should teach anatomy and proportion; another, architecture, isometrical perspective and perspective; a third, landscape and nature in general; indeed, professors might be appointed to teach every branch of art, science, and literature; as in the British Museum every thing requisite is on the spot, and few alterations in the establishment would be needed. The National Gallery, and the National Gallery of Practical Science, might become branches of the British

Museum. The grand object of a student should be to divide his time so as not to lose any, and not to give too much study to one pursuit or branch of the art. I firmly believe that the arts are useful to every branch of manufacture in the land; there is hardly a branch one can name that is not useful, from the lowest to the highest state of society; even to our legislature, drawing is useful, for they are not capable of judging of a plan without a knowledge of it; and they are consequently compelled to apply to practical men, and sometimes to dull-headed practical men, who are likewise often unacquainted with drawing, to have their opinion on any new principle in plans that may be laid before them.

Have you any other observations to offer as to china-painting?—No more.

You conceive, that were the artists instructed better in the principles of drawing, by improving the beauty of their productions, you would extend their sale?—Yes, and it would not depend too much on fashion, as it did when it was merely a passing thing, except that it would pass into other countries, and the beauty of design and workmanship would be admired in foreign countries, and be valuable in the commerce of that article.

At present, in china-painting, do we invent designs, or simply copy old ones already existing?—When I commenced, I invented my own designs, but that was peculiar, perhaps, to me; Mr. Muss and Mr. Marsh used occasionally to design their own.

At present do we invent as much, or copy more?—It has fallen so low, that what is done is not worthy of being called invention; the French are beating us hollow.

Independently of extending the sale of works of art, you would think you would confer on them a permanently intellectual interest, were the artists well instructed?—Yes; when we understand drawing, we cannot bear to look at a thing ill drawn; it affects the feelings in an uncomfortable manner.

Do you not think that the Wedgwood ware, which is made from the cheapest and commonest materials, by being made of beautiful forms and being covered by beautiful designs, has attained a rank it otherwise could not have obtained?—Yes, certainly; they are beautiful works of art, and though of the commonest materials, we are delighted with the forms. Painting will only interfere with the beauty of the form when it is very excellent; it is a rule in composition never to put an ugly object before a graceful one.

You mean that genuine beauty becomes permanent, and independent of fashion?—Yes, accidental circumstances can never affect real beauty; I have seen beautiful pieces of china in form disfigured by bad painting; in consequence of that, I have my china generally without any painting, as I like the form undisturbed; and though the other cost more, I would rather have given the larger price for the plain china, than for that which was painted, unless the painting was good.

Do you think china-painting might become an extensive means of developing designs?—Yes, it is perpetually before us; every day we see china; at all our meals the elegant and beautiful china is always before us; we are delighted with a piece of beautiful workmanship, and it might be rendered very cheap if there were a great number of clever draughtsmen as china-painters, but you could not find them now.

Few things come so constantly under the eye as china?—No, very few.

Can you give any information as to the state of glass-painting?—Yes, I was more occupied by glass-painting than any other branch before I became an artist.

Have the goodness to give the Committee such information as you have been induced to collect on the subject of glass-painting?—Glass-painting has fallen almost to the same level as china-painting; but it might be greatly superior now to what it was in ancient times. There is an ignorant opinion among people that the ancient art of glass-painting is completely lost; it is totally void of foundation, for we can carry it to a much higher pitch than the ancients, except in one particular color, which is that of ruby, and we come very near to that. We can blend the colors and produce the effects of light and shadow, which they could not do, by harmonising and mixing the colors in such a way, and fixing by proper enamelling and burning them, that they shall afterwards become just as permanent as those of the ancients, with the additional advantage of throwing in superior art.

Do you think that the glass-painting artist wants instruction in correctness of design as much as the china-painter?—Yes, more, as it is a higher branch of art; but one of the greatest drawbacks of glass-painting, and the great cause of its being neglected, is this: it is so liable to be broken, that no person can venture to pay the artist sufficintly for his labor, on account of the thin and brittle material on which he is obliged to work.

You think there is a want of encouragement?—Yes, or else glass-painting must have surpassed all other branches of art in splendor, as it is capable of producing the most splendid and beautiful effects, far superior to oil-painting or water-colors; for, by the transparency, we have the means of bringing in real light, and have the full scale of nature as to light and as to shadow, as well as to the richness of color, which we have not in oil-painting nor in water-color.

When you were employed painting on glass, did you find the Excise laws present any great obstacle to the improvement?—Yes, that was the greatest obstacle. We intended to make experiments on plate-glass; I did, and succeeded with it, but the expense of plate at that time, in consequence of the heavy duty, finally put an end to those experiments, as we could neither afford to purchase such expensive glass, nor to erect larger annealing-kilns, for if not properly annealed, the glass is liable to fly. I believe I was the only person who made experiments on plate-glass; they were supposed to be successful, only I could not afford to carry them on, for the reason before given. This is the principal cause of the fall of painting on glass, but if I could have made my experiments duty-free, I should have succeeded, for the plate-glass is so thick that it would be safe from being broken by ordinary means, and it has besides another advantage, that plates can be obtained sufficiently large to obviate the necessity for those bars which interrupt the present works.

Are the artists who pursue glass-painting now well educated in drawing?—No, the want of that knowledge has helped its decline; Mr. Hedgland, the architect, Mr. Hoadly and Mr. Oldfield, are, I believe the principal glass-painters remaining.

At the present time you think the cause of the badness of execution is owing to the want of education in drawing?—Partly so; I should have painted some of my own subjects, as the effect produced on glass would be particularly adapted to them, if the experiments, &c. had been less expensive. I have always regretted the cost of the experiments, as works executed on plate-glass on a very large scale would have been most magnificent in cathedrals or great public buildings; the knowledge and experience we had gained from our various experiments would have enabled us to produce grander works than had ever yet been seen in public buildings. I did not leave this branch of art without establishing a mode which has been, and will remain in use as long as glass-painting is an art.

Why did you discontinue it?—I could not get a snfficient price for a highly-finished work to pay for the hazard; I painted some very highly-finished paintings which were purchased by Lord Ennismore, who was very fond of glass-painting, and I finished Mr. Charles Muss's works, when he died in 1824.

After you left glass-painting you became historical painter and engraver, and have executed your own designs?—Yes.

Is there any protection for copyright in those original compositions?—Not the least; for the expense is so great, that even if we gain our action we sustain great loss, and can only recover so much as we can prove has been sold; and it is no easy matter to prove more than the sale of one or two prints, although we may know a thousand have been sold; we are therefore ruined if we go to law. I have in my own person experienced great losses from the system, as the French copies of my works are brought over from France and sold in every part of the country. I was told that various shops in Windsor had got my works lithographed and selling at very low prices, to my complete ruin; and if I am not protected by some new law, I shall be compelled entirely to leave that branch of the profession by which I live; for my pictures are so extensive and cost me so much labor that I cannot subsist by painting, as very few can pay me 1,000*l.* or 2,000*l.*, and I cannot execute them for less.

What is the principal defect; this expensiveness of the law?—Yes, in a great measure; it costs so much money to carry the law into execution, and as it is not exactly clear, we are not sure, after all, that we shall not be beaten, though our proofs are ever so good. The person may come forward with false witnesses, and swear that he did not sell.

But you have obtained an injunction?—No, I cannot get an injunction; I applied for one to prevent a person from exhibiting a copy of my work in a sort of diorama of Belshazzar's Feast, in Oxford street, and that person contested it with me. This diorama was a most infamous piece of painting, and the public were given to understand that I was the painter; this was ruining my reputation, and at the same time taking that from me which ought to be my own, my copyright. I ought to have the power of demanding so much money for permission, but this copy was made not only without my leave, but my name given as the painter. I endeavored to stop the exhibition by an injunction, but was referred to a jury.

Is there any remedy that presents itself to your mind for protection?—Yes; I think I could be protected with regard to the law of copyright of engravings, &c., and take this opportunity of showing how incorrect is any opinion that may prevail as to the sufficiency of the present protection; for the plagiarist is not only safe from prosecution on account of the expense of such prosecution outweighing all the advantages that can be derived from a verdict; but as in my own case, he even comes into the field with a cheaper production, supported by all the effect of the advertisements, and other expensive means of publicity that my own performances had led me to adopt. He not only robs me of my ideas, but establishes a lucrative trade on the effects of my pecuniary outlay; wherefore I have always thought, and I still think, that the copyright should remain in the person of the designer, so long as he lives, and of his heirs, so long as they possess the works, the same as any other property, unless, of course, there be a distinct written agreement to the contrary. That it should be so is obvious, but there is not in fact any real protection to copyright, owing to the uncertain state of the law on the subject. Supposing, for example, that in the case of pirated copies of my engravings, I do by chance obtain a verdict from a jury, I can only recover the amount of what I can prove the defendant to have actually sold, which is my sole compensation for the thousands that are known to have been sold, but which it would be impossible to prove by evidence, since open book accounts of such transactions are never kept. Or take another case, of a picture being copied for a dioramic or other exhibition; suppose that on applying for the injunction, his Honor is not able to distinguish the difference between a picture of Belshazzar's Feast and a piece of lace, and leaves it for a jury to decide whether a diorama is to be considered a painting, or a copy coming under the meaning of the Act; all the satisfaction I obtain is heavy law expenses, with a certainty of an enormous increase if I hazard an action. The above cases are enough to prove that there is no efficient protection; but there are many other ways of infringing a copyright, one of which is, that any unprincipled person may copy an early and most imperfect work, and publish it as if just executed, although the publication of such a puerile attempt would never have been sanctioned by the artist from a regard to his own reputation. I will venture to suggest a method of protection; a committee of gentlemen and artists might be appointed to sit at the museum about once in the fortnight or month; say in the following towns, namely, for England, London, Bath, Liverpool, Birmingham, Hull, and Newcastle-upon-Tyne; for Scotland, Edinburgh and Glasgow; and for Ireland, Dublin and Cork, for the purpose of receiving and registering impressions of original works, after which the copyright should be considered as fixed; and all false copies found in any part of the United Kingdom, after the copyright has been fixed, should be seized. We should, likewise, have the power of seizing all foreign copies as smuggled goods, and treating the possessors accordingly. Thus no print should be protected unless deposited at the Museum, or whatever othor place or places might be appointed; I think by that it

would be put a stop to. I would have it at the British Museum, certainly; it would be desirable also to have them in each manufacturing town.

(To be continued.)

Upton's Rotatory Lever Engine and Boiler.—The advantages of the engine are:—1. It occupies only a seventh part of the space of the common reciprocating beam engine of equal power. 2. It has neither engine-beam, crank, connecting-rod, parallel motion, governor, air-pump, hot-water cistern, nor any of the attendant expenses. 3. It is so constructed that, whether single or double, the steam operates upon the extremity of a lever, the fulcrum of which is the axis of the engine, as well as of the resisting force, as in the case of paddle-wheels fixed at each end thereof, or of coach-wheels for locomotion on land. 4. It costs less in the first purchase, and does not require a tenth part of the expense in fixing or repairs, as compared with a beam-engine. 5. It can be made to operate alternately in opposite directions, by reversing the motion of the steam. 6. It is perfectly controllable, and may be set to work or stopped instantly by any person whatsoever, if necessary.—7. It has not half the friction of common beam-engines, and, consisting of only about a dozen parts, will prove infinitely less liable to derangement, and thereby greatly increase the demand for them. 8. It can be entirely put together in the manufactory, and will require only a few days' fixing, instead of weeks, as beam-engines always occupy. 9. It is admirably adapted for team cultivation, being the best constructed engine for steam-ploughing, grist-mills, and other agricultural operations. 10. It is the best application of steam power for canal, river, and sea navigation; can be fixed to the kelson of a ship, and the axis protruded through the sides by means of perfectly secure stuffing boxes, so that the paddles may be always under water, and more out of the way of the enemy's shot. 11. It will weigh the anchor, pump the ship, and discharge and take in the cargo. 12. It requires less fuel than beam-engines of equal power, and, by occupying less space, leaves more stowage-room for goods. 13. It will be found, from its simplicity and compactness, the best application of steam-power for railways or common roads, and the most profitable engine for manufactories and mining operations. 14. It will propel a carriage at the rate of fourteen miles the hour, including stoppages for water and fuel. 15. It will not weigh,—including boiler-carriage, 16 passengers, half a ton of luggage, 75 gallons of water, and 3 sacks of coke in reserve,—more than 5 tons.

The advantages of the boiler are:—1. Its decided superiority over all other boilers yet made, consists in its being founded on the well known principle of an air-furnace, which of all others is the best adapted for the purposes of combustion, and generating the most intense heat with the least possible expense. 2. It weighs less than any other boiler yet made, generating the same quantity of steam. 3. It is safer than any other boiler, as it carries its fuel and water in separate compartments, the giving way of any one of which does not interfere with the others. 4. It is stronger than any other boiler, from the peculiarity of its construction. 5. It consumes less fuel than any other boiler yet made. 6. It works either as a high or low pressure boiler. 7. It raises steam in less time than any other boiler, and is fed from the top, but may be constructed to be fed otherwise if required. 8. It is more durable than any other boiler, and any one of the compartments for generating steam may be taken out and repaired, or replaced by duplicates, in a few hours. 9. It is the best adapted boiler for shipping evr discovered, being lighter, more compact, fed from the deck, and perfectly safe by not carrying its water in bulk; nor can any danger result, even should one of the steam chambers give way after long wear and tear; besides which, it stands on its own legs, and requires no fixing or brick work. Notwithstanding which, its heat is prevented from being acted upon by the surrounding atmosphere, and the steam is collected and preserved in one of its chambers, placed in the midst of the fire and boiling water. 10. It is the best boiler ever made, whether for stationary or locomotive purposes, on land or water. [John Upton, Agricultural and Locomotive Steam-Engine Manufactory, 7 New Street, Southwark Bridge, London.]

Experimental Researches into the Laws of the Motion of Floating Bodies. By J. S. Russell.—It was the object of these inquiries to assist in bringing to perfection the theory of Hydrodynamics, and ascertain the causes of certain *anomalous facts* in the resistance of fluid, so as to reduce them under the dominion of known laws.

The resistance of fluids to the motion of floating vessels is found in practice to differ widely from the theory, being, in certian cases, double or trible of what theory gives, and in other and higher velocities, much less. These deviations have now been ascertained to follow two simple and very beautiful *laws*:—1st. A law giving a certain *emersion* of the body from the fluid as a

function of the velocity. 2nd. A law giving the resistance of the fluid as a function of the velocity and magnitude of a wave propagated through the fluid, according to the law of Lagrange. These two laws comprehend the anomalous facts, and lead to the following

Results.

1. That the resistance of the fluid to the motion of a floating body will rapidly increase as the velocity of the body rises towards the velocity of the wave, and will become greatest when they approach nearest to equality.

2. That when the velocity of a body is rendered greater than that due to the *wave*, the motion of the body is greatly facilitated: it remains poised on the summit of the wave in a position which may be one of stable equilibrium; and this effect is such that at a velocity of nine miles an hour the resistance is less than at a velocity of six miles behind the wave.

3. The velocity of the wave is independent of the *breadth* of the fluid, and varies with the square root of the *depth*.

4. It is established that there is in every navigable stream a certain velocity at which it will be more easy to *ascend* the river against the current than to *descend* with the current. Thus, if the current flows at the rate of one mile an hour in a stream four feet deep, it will be easier to *ascend* with the velocity of eight miles an hour on the wave, than to *descend* with the same velocity behimd the wave.

5. That vessels may be propelled on the summit of waves at the rate of between twenty and thirty miles an hour.—[Proceedings of the British Association at the Dublin Meeting, August, 1835, London and Edinburgh Philadelphia Mag., vol. vii., p. 302.]

On an Economic Application of Electro-magnetic Forces to Manufacturing Purposes. By Robert Mallett.—The separation of iron from brass and copper filings, &c., in work-shops for the purpose of the refusion of them into brass, is commonly effected by tedious manual labor. Several bar or horse-shoe magnets are fixed in a wooden handle, and are thrust, in various directions, through a dish or other vessel containing the brass and iron turnings, &c., and when the magnets have become loaded with iron, it is swept off from them by frequent strokes of a brush. This is an exceedingly troublesome and inefficacious process.

It appeared to the author that a temporary magnet of great power, formed by the circulation of an electric current round a bar of iron, might be substituted adventageously. The following is the arrangement which he has adopted. Several large round bars of iron are bent into the form of the capital letter U, each leg being about six inches long. They are all coated with coils of silk-covered wire, in the usual way of forming electro-magnets of such bars, and are then arranged vertically, at the interval of five or six inches from each other.

All the wires from these coils are collected into one bundle at their respective poles, and there joined into one by soldering, a large wire being placed in the midst of them and amalgamated. A galvanic battery is provided, which, if care be taken in making the junctions at the poles, &c., need not exceed four, or, at most, six pairs of plates, of from twenty inches to two feet square.—The poles of this terminate in cups of mercury, which are so placed that the large terminal wires of all the coils can be dipped into them, or withdrawn easily.

The rest of the arrangement is purely mechanical. The required motions are taken from any first mover, usually a steam engine. The previously described arrangement being complete, a chain of buckets is so contrived as to carry up and discharge over the top of the magnets a quantity of the mixed metallic particles: most of the iron adheres to the magnets, while the so far purified brass falls into a dish or tray placed beneath to receive it. This latter is also one of a chain of dishes, the horizontal motion of which is so regulated that the interval between two dishes is immediately under the magnets, in the interval of time between two successive discharges of the mixed particles on the bars.

At this juncture the communication between the galvanic battery and the magnets is interrupted by withdrawing the wires from the cups of mercury, and the result is, that the greatest part of the adhering iron drops off and falls in the space between the two dishes. The next dish now comes under the magnets, the communication is restored, and a fresh discharge from the buckets takes place, and so the process is continued.

Some iron constantly adheres to the magnets but this is found of no inconvenience, as it bears but a small proportion to the total quantity separated.

The author has had an imperfect apparatus of the sort above described at work for some time, and has found it to answer; and suggests the application of electro-magnets for somewhat as analagous objects in various manufactures. He particularly mentions needle and other dry grinding.—[Proceedings of the British Association: Lond. and Edinb. Phil. Mag., vol, vii., p. 305.]

BERGIN'S PATENT RAILWAY BUFFING-APPARATUS.

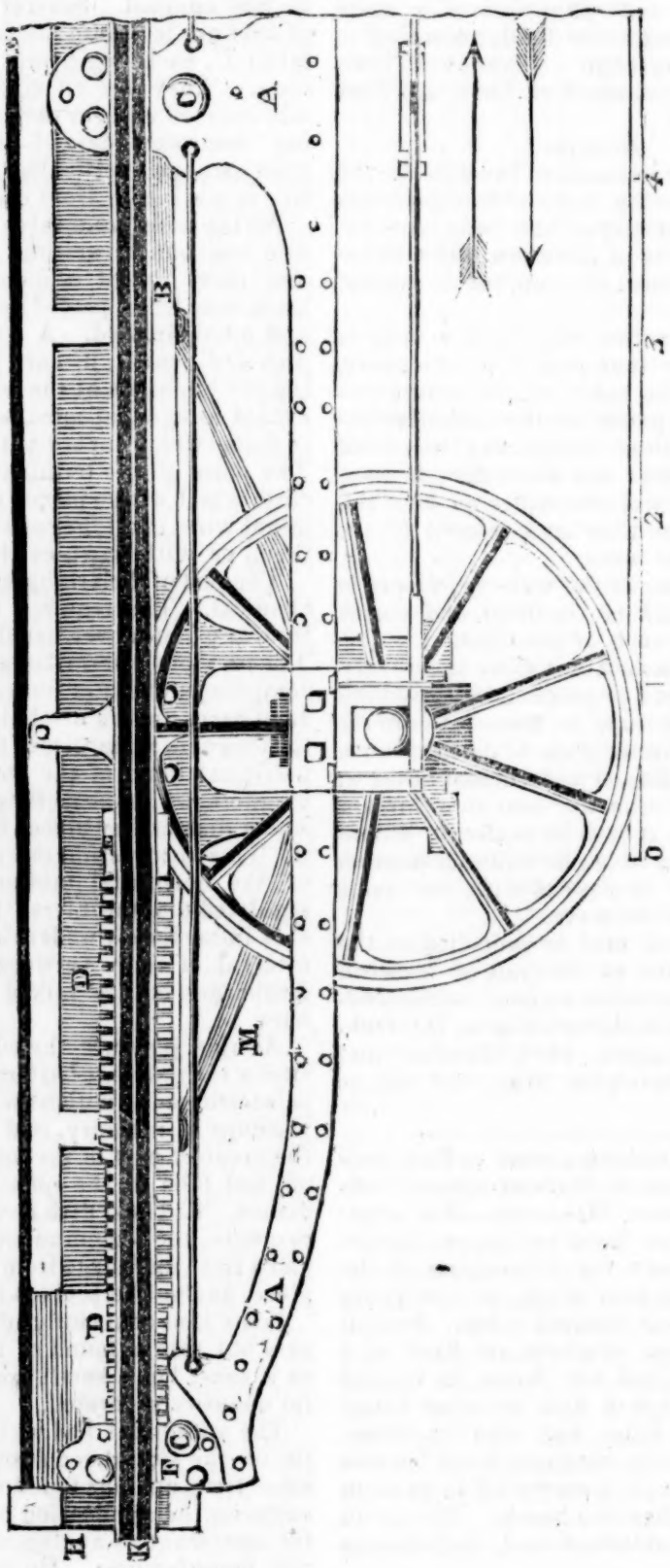


Fig. 1.

[From the London Mechanics' Magazine.]

BERGIN'S PATENT RAILWAY BUFFING-APPARATUS.

We have more than once had occasion to mention the ingenious buffing-apparatus which Mr. Bergin, the intelligent Secretary of the Dublin and Kingstown Railway, has applied to the carriages under his superintendence, and the good effects which have resulted from its adoption. Our attention is again drawn to the merits of the invention by the Third Annual Report of the Board of Public Works in Ireland, now before us, in which we find it spoken of in the following favorable terms :—

"Thomas F. Bergin, Esq., Secretary to the Company, has applied to the carriages a spring-bar (for which he has obtained a patent,) admirably adapted to ease the shock of sudden stopping or putting in motion, while, at the same time, it is more strong, more simple, and much more economical, and attended with other great advantages, over the system hitherto adopted."

A description of the apparatus, furnished by Mr. Bergin, and illustrated by engravings, is annexed to the Commissioners' Report. We shall now transfer the former, with but little abridgment, to our pages ; and so much, also, of the latter as is necessary to a clear understanding of the construction of the apparatus.

MR. BERGIN'S DESCRIPTION.

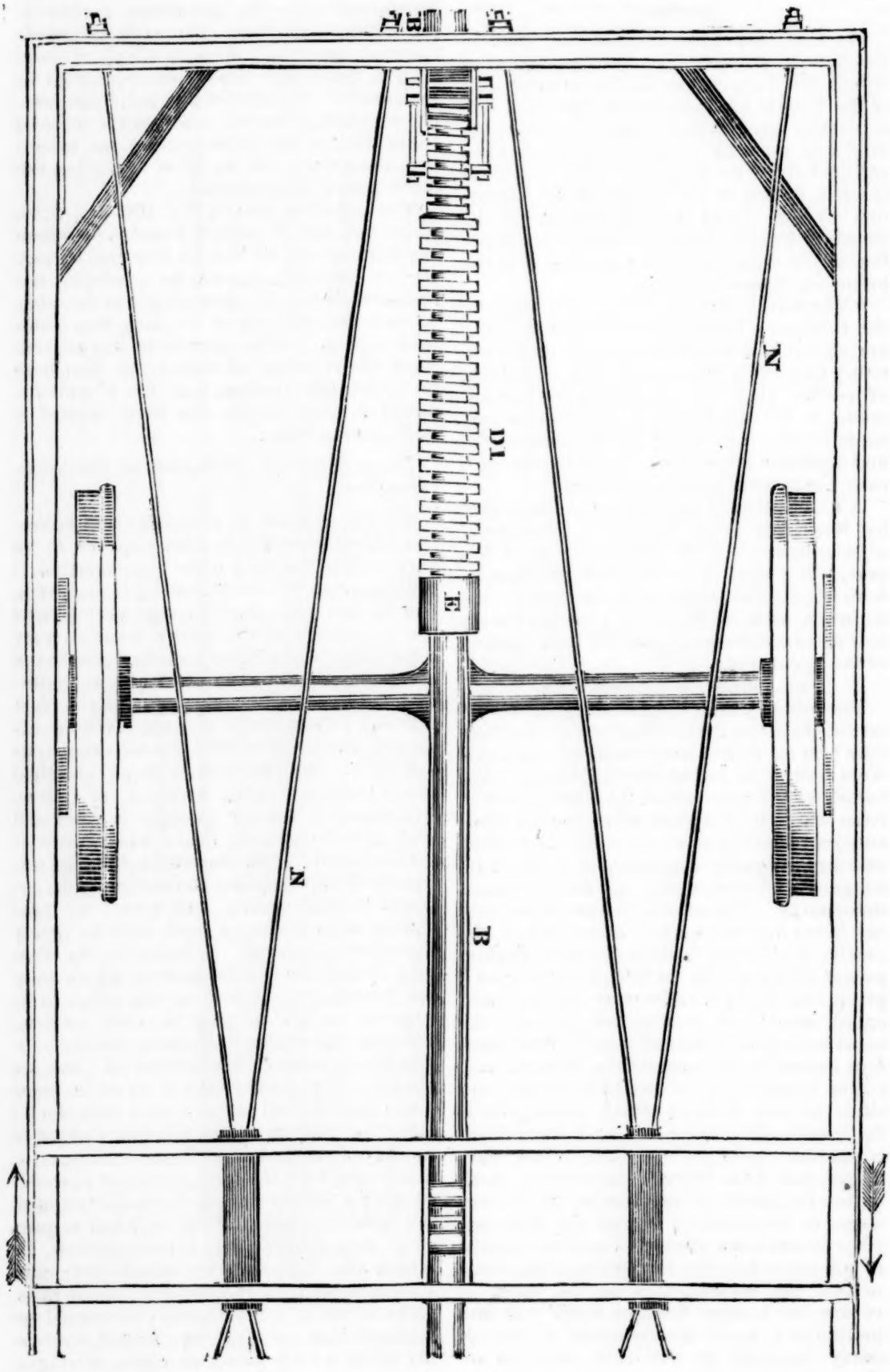
Immediately after commencing the traffic on the Liverpool and Manchester Railway (the first on which long trains of carriages were moved by locomotive-engines at high velocities), it was found that every time a train was put in motion or stopped, violent concussions took place between the several carriages, equally disagreeable to the passengers and destructive to the carriages themselves. These concussions arose from the following cause, viz. by reason of the inertia of all heavy bodies, the same engine-power which would be adequate to draw a given load along a railway at any required speed, would not be sufficient to start the same load from a state of rest ; it was therefore necessary to connect the several carriages by chains of considerable length, say three or four feet, by which arrangement the inertia of the train was,as it were,divided into as many parts as there were carriages, and these several parts being each within the power of the engine, were overcome in succession ; but as the first carriage would have attained a certain amount of velocity when the connecting chain came to pull the second, this second must of course be at once dragged from rest into motion at a speed nearly equal to that already acquired by the first, and so on through the entire train. Now a very slight knowledge of the principles of mechanics teaches that the concussions already mentioned were the necessary results of the action described; the same principle (inertia) produced the same effects at stopping a train, and also at every change in the relative velocities of the individual carriages when in motion ; and as the force of these shocks was dependent on the velocities, the greater the speed of travelling the more violent they became.

The obvious remedy for the evil complained of was to provide a means by which the full amount of motion acquired by any part of the train should be gradually, not instantaneously, communicated to the other parts : the elasticity of a spring was a suitable means, and an apparatus was accordingly added to the Liverpool and Manchester passenger coaches, a sketch of which is annexed, and which has been termed a buffing-apparatus.

[Here follows a description of this apparatus] :—

This apparatus is complex, and consequently expensive ; it also requires to be very strong, as on a little consideration it will be evident that the spring-bars, levers, and frame of the first carriage have to bear the resistance of the entire train ; a very rigid spring is therefore necessary, the range of action of which is, of course, very limited, (in practice not exceeding a few inches,) consequently the concussions, although much diminished, are still very considerable. The apparatus being attached to the carriage-frame, which is, of course, supported on bearing springs, it rises and falls according to the load ; whence it constantly occurs, from the carriages being unequally weighted, that the buffer-heads, opposed to each other, and which by right should be at the same level, vary by nearly their own diameter. Whence, in the event of a violent blow, the bars to which they are fastened are almost certain either to be bent so as not to play in their sockets, whereby the whole apparatus becomes inoperative ; or else to be broken off (such we have found to be the case in every instance when an unusually severe blow took place.) After the apparatus described was added to the Liverpool and Manchester carriages, it was found that the train no longer proceeded with a steady motion in the direction of the rails, but that each carriage had acquired a very considerable lateral motion, by which the flanges of the wheels were constantly striking or rubbing against the rails, so as to cause a considerably increased resistance from side friction ; indeed, on looking along a train of six or eight carriages, the serpentine motion is very striking. The

Fig. 2.



cause of this unsteady motion will be evident, when we recollect that the point from which each carriage is drawn is in one direction, the centre, and in the other the after extremity. These considerations, the result of numerous careful examinations of the carriages on the Liverpool and Manchester Railway previous to ordering our own, led me to seek for a remedy; as on the Dublin and Kingstown Railway, so very large a proportion of the traffic of which would be passengers, the extent of which would be difficult to anticipate, but which must of necessity be immense, it became a matter of paramount importance to attain, as far as practicable, the most perfect comfort and security, and also to reduce, as much as possible, the wear and tear of the nuwerous carriages which the company must provide. The apparatus which I designed, and which has been successfully applied to thirty-five of our carriages, is represented in plan, section, and elevation, in the accompanying drawings.*

A slight frame of sheet-iron, AAA, consisting of two similar plates, three inches apart, each about 3-16ths thick, secured together by rivets, rests on turned bearings on the centres of the axles; a single bar, BB, (I have used a wedded iron tube of 5-16ths inches thick, and three inches diameter, as being the stiffest,) the entire length of the carriage, and extending about two feet beyond each end, passing through an oblong hole three inches wide and nine inches long (H, 4), is supported on this frame by rollers, CCC, allowing it to be moved lengthways with great facility; on this tube or bar BBB is placed at either end (without the framing of the carriage) about four feet of spiral springs, DDD, of graduated strengths; one end of each of these sets of springs rests against a strong collar or boss, E, fixed to the bar or tube, and the other end against a small box of iron, F, attached to the frame A, and furnished with one of the rollers C previously mentioned; also with the two friction rollers G and G projecting a little beyond its surface, and resting against the inner side of the carriage-frame end. To each extremity of the tube BB is attached a buffer-head, I, by means of a bar of iron K, passing through BB, and furnished with a nut and screw at each end; immediately within the buffer-head, and resting against, is a bar of iron, L, for attaching the carriages together. It will be observed, that this apparatus lying loosely on the axles, is perfectly independent of the frame-work of the carriage, which is supported in the usual manner on bearing springs, MM, and, in consequence of the oblong holes HH, rises or falls according to the load without affecting the buffing apparatus. The action of the apparatus is as follows:—The train being to be moved in the direction of the upper arrow, the motive power is applied to L 1, and draws forward the central tube BB, thereby compressing the springs DD between the boss E and the friction roller-box F, which rests against the end of the carriage-frame, without moving this latter until the elastic force of the compressed springs becomes sufficient to overcome the resistance presented by the friction and inertia of the carriage, when the latter begins to move forward so gently as not to be perceptible to persons seated therein; the second and each succeeding carriage in the train is, by similar means, brought from a state of rest into motion, as (altogether independent of the springs DD,) the tube BB acts on B 2 merely as a simple connecting chain, rope, or bar, would. In case of a concussion from behind, or of one carriage running against another, it will be at once seen that the resistance is offered by the furthest end, the effect being to drive the tube BB forward, compressing the springs at the remote end; and the carriage will not be affected by the blow until (as in drawing the train) the elasticity communicated to the springs overpowers the inertia of the carriage, which then begins to move, actuated by a force just sufficient to start it; any ordinary velocity might be thus (theoretically) resisted by sufficient length of spring, without any strain or violence to the carriage receiving the blow; but practically, the springs are limited to about four feet, allowing a range of action of about two feet, beginning to be compressed by a force equal to about twenty pounds, and presenting a gross resistance to entire compression of upwards of two tons, and which have been found sufficient for all practical purposes. It will be observed, that as the springs of each carriage act totally independent of each other, and of all the carriages in the train, except to that to which they are attached, each has but to bear its own share of the resistance, the sum of which is made up of the separate resistances of all the springs acted on: thus, if one set offers a resistance equal to two tons receding through two feet, and that there be ten carriages in the train, the gross resistance to a concussion would be equal to twenty tons through two feet; and if the buffer-heads of each carriage were in con-

* We have given the section and plan only (our figs. 1 and 2,) and have omitted the after-part of the carriage-frame in each, as it is an exact counterpart in every particular of the front part. We have also, for convenience sake, given detached views of the buffer-heads; figs. 3 and 4, being a section and plan of that in the front, and figs. 5 and 6, a section and plan of that in the rear.—Ed. M. M.

tact, this gross amount of resistance would be opposed without the carriages being necessarily moved forward, as in the case of any obstruction on the rails, or any of them bearing more than two tons. On the contrary, in the other apparatus, supposing each spring also to resist a force of two tons, and to recede, as in the case in practice, about eight inches, each spring being acted on by all that preceded it, the resistance offered by a train of ten carriages would be but equal to two tons through ten times the space each separate spring moved, or $10 \times 8 = 80$ inches, or 6 feet 8 inches; consequently the first and each succeeding carriage would, to enable all the springs to act, be forced through a space equal to the sum of the spaces through which the separate springs act: thus the first carriage of the ten would be forced through eight inches for each of the remaining nine carriages, or in all six feet, and it is easy to conceive the difference of the effect in the two cases. Experiments have been tried on this railway, by placing a single carriage, fitted with the new apparatus, on the rails, and running an engine and tender against it with a velocity of six to seven miles an hour, without producing any injurious effect. I have more than once sat in a carriage so struck, without sustaining any injury or other effect greater than is felt on starting a train of carriages fitted with the old apparatus.

Another effect which has been realised by the adoption of this apparatus is a perfectly steady forward motion in the trains, whereby very much of the side friction of the flanges of the wheels against the rails is avoided; and instead of that undulating lateral motion previously described, all the carriages constituting the train move forward in a steady path, as if they had not the power of motion independent of each other. Carriages are hereby rendered much less liable to go off the rails, and can be pushed before the engine in case of necessity with far greater confidence and less liability to accident; as although the impulse is given to the central bar from behind, yet it is obvious the carriage is acted upon from the front, precisely as it would be if drawn in the same direction. I have frequently, during our experimental trials before opening the railway, propelled one and two carriages in this manner at a velocity of thirty miles per hour with perfect safety. The diminution of side friction necessarily diminishes the power requisite to draw a train: the amount of saving in this respect I have as yet been unable to ascertain experimentally with sufficient accuracy to state in this place; I have, however, ascertained that it s very considerable.

One other object, of no trifling importance to a concern like the Dublin and Kingstown Railway, which must have an exceedingly large stock of carriages, is also effected; namely, a diminution of first cost of between 50*l.* and 60*l.* per carriage.

In describing the figures, I omitted to state that as the entire resistance to the action of the springs D D is on the ends of the carriage-frame, the centre of each is armed with a strong plate of iron, about fifteen inches square, through which pass the tension rods N N to the outer angles of the opposite ends of the frame; consequently these rods receive the entire force of the springs.

Fig. 3.

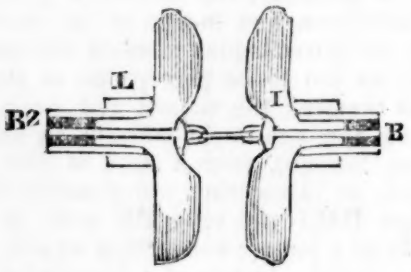


Fig. 4.

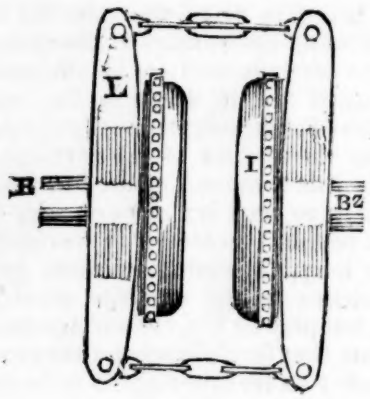


Fig. 5.

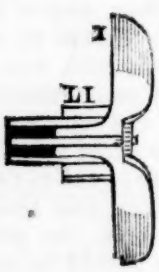
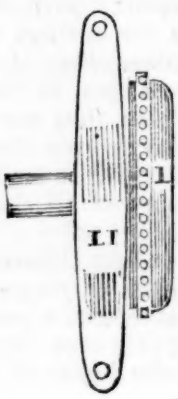


Fig. 6.



HUNTER'S STONE-PLANING MACHINE.

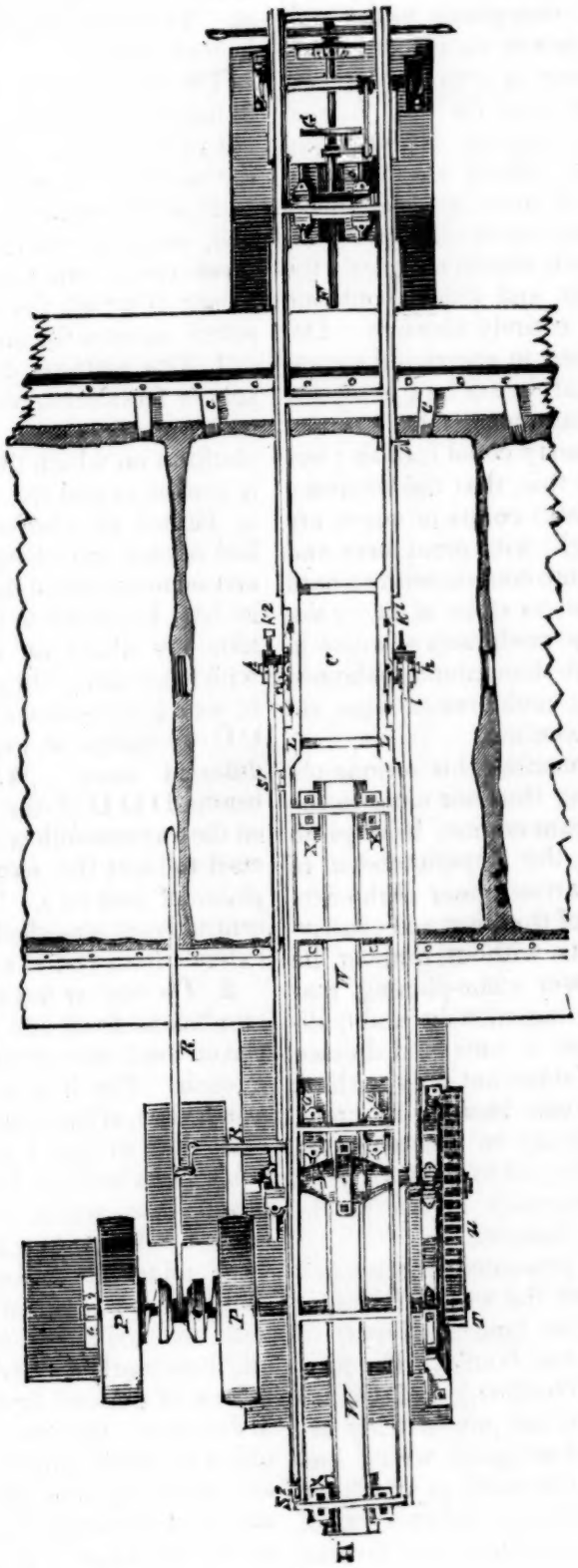


Fig. 1.

From the London Mechanics' Magazine.

HUNTER'S STONE-PLANING MACHINE.

Among the few exceptions to the universality of steam-power as a first mover, which existed a year or two ago, by far the most important was its very limited applicability to the cutting, dressing, and fashioning of stone. Many attempts had been made—some of them by machinists of first-rate eminence—to construct a steam-power machine which should supersede the mason's hand-mallet and chisel; but one and all had proved entirely abortive. Difficulty there was none in contriving steam-machinery that would slice or hew in pieces, and even with great nicety, the stoutest blocks which the quarry could furnish; but the difficulty lay in this, that the immense friction to which metal points or edges are subject, when brought with great force and in rapid succession into contact with so hard and gritty a material as stone of every description, caused so prodigious a waste in tools, that it far more than counterbalanced any advantage that could result from superior celerity of execution.

The merit of overcoming this serious objection, and of adding thus one more to the triumphs of the steam-engine, belongs to Mr. James Hunter, the Superintendent of the Leysmill Quarries, near Arbroath. After several years of thinking and contriving, and experiments without number, he has invented a power stone-planing machine, which is so ingeniously and judiciously contrived, that it cuts and dresses the largest blocks of stone not only with as much exactness as can be done by hand, but with so little injury to the tools, and with so much rapidity, as to leave all hand labor, in point of economy and despatch, at an immeasurable distance.

We have before presented our readers with some samples of the wonderful capabilities of this machine, (see the Report of Messrs. Carmichael and Kerr, C. E., published in our 612th Number,) and we are glad to have it now in our power to lay before them the first description which has appeared of the machine itself, to which we shall add some additional information of great interest which we have been favored with by the patentee respecting its performances.

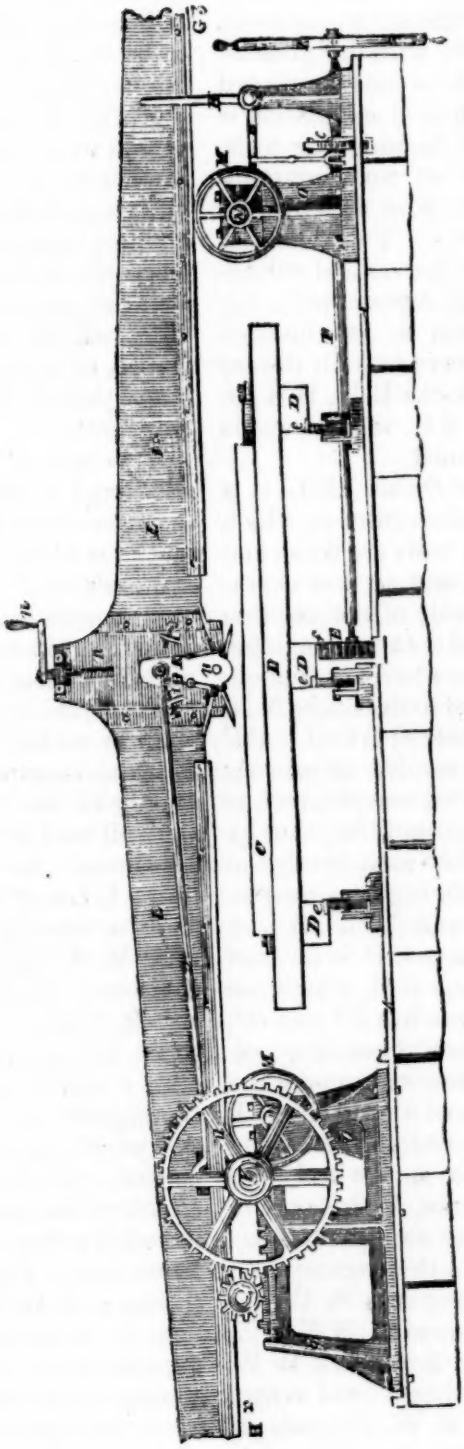
The engraving (fig. 1) on our front page represents a plan of the machine as it appears in its complete state when fixed and ready for working, to a stone bed or foundation; and fig. 2 is an end elevation thereof. The steam-engine employed is omitted in both views.

The machine, of which AA is the sole or foundation plate, consists of three principal parts; *first*, a platform, which carries the stones to be planed; *second*, two tilt or cant blocks, which hold the planing tools; and, *third*, a traversing-frame, in which these tilt or cant blocks are fixed, and by means of which the tools are brought into action against the surface of the stone.

1. The *platform for the stones*. On the sole or foundation plate AA, three rows of traverse-rollers *a a a* are fixed. B B is the platform on which the stones C C are laid; it moves to and fro on the rollers *a a*, and is formed of planks, four inches thick, laid across three longitudinal beams D D, and securely bolted thereto. The two parallel bars *b b* nailed to the surface of this platform are about an inch thick, and faced with plate-iron; they serve as ledges within which to secure and steady the stones C C, by means of loose chocks of wood of different sizes. Where the longitudinal beams D D D of the platform rest or bear on the traverse-rollers *a a a*, they are strengthened to meet the extra pressure by underplates of iron *e e e*. To the bottom of the central beam a toothed rack *f* is fixed, which extends from end to end.

2. *The cant or tool blocks*. BK, BK, are two blocks fixed into the traversing-frame, one on each side, with two tools i^1 i^2, k^1 k^2, in each. Fig. 3 is a front view and fig. 4 a side view, of these cant-blocks, on a longer scale than in figs. 1 and 2. They turn on studs *h h*, which are fixed in vertical sliding-blocks *m m*, which are moveable up and down by the screws and handles *n n*, so as to be adjustible to any thickness of stone that may be required to be cut. The two tools marked i^1 and k^1 are roughing tools, and those marked i^2 and k^2 are finishing tools. All are of a round form, and about an inch in diameter; the two finishing ones have chisel or broad mouths. Both sets of tools are fixed in wrought-iron tubes *o o* by means of adjusting screws *p p*, which tubes are turned so as to fit accurately into holes bored in the cant-blocks B K. To each set of tubes in which the finishing tools are fixed a short lever *q* is keyed on, the upper end of which is slightly curved and toothed, and

Fig. 2.



ELEVATION.

above it there is a horizontal screw *r*, which works into the teeth of this lever *q*, so that by applying a spanner to the square head *s* of the screw *r*, the finishing tool may, through the medium of the screw, the lever, and the tube, be adapted with the greatest nicety to the surface of the stone to be planed and dressed. No such nice adaptation is necessary in the case of the roughing tools, and to them, therefore, no such adapting lever is applied. G, fig. 3, is the cover for the pivots of the screw *r*. Two brackets are affixed to the face of the vertical sliding-blocks *m m*, in the manner represented in fig. 1, and two screws, *t* and *u*, are inserted therein, which screws serve to limit the arc described by the cant-blocks B K, B K, in turning on the studs *h h*, as afterwards more particularly explained.

3. The *traversing-tool frame.* L L is a large sliding-frame, in the centre of which the working or planing tools are fixed, and which has a space of about six feet to traverse in, three on each side of the position in which it is represented in the engravings. This frame rests on four wheels or friction-rollers M M M M, affixed to the shafts N N, which revolve in brackets O O O O. P P are two pulleys, which revolve on an axis fixed in the standards G G, one of which is worked by an open strap, and the other by a cross strap, so that they may revolve in opposite directions, and thus give a reciprocating motion to the frame L L. Q is a clutch between the pulleys P P, connected with the handle and crank R R, which are acted upon by studs or catches S^1 and S^2, projecting from the sides of the sliding tool-frame L L in such manner as to make the clutch operate on each tool alternately. T is a pinion fixed to the end of the axis of the pulleys P P. U, a spur-wheel, into which the pinion T works, V the axis of this spur-wheel, on which axis there is fixed a pinion (not seen in the engravings), which works into a sliding-rack W W, the teeth of which point downwards. X X X X are the bearings on which the rack W W slides. Y Y is a strong beam fixed across the back of the rack W W, the ends of which project through the sides of the sliding-tool frame L L. Z Z are two connecting-rods, which pass from the ends of the beam Y Y to the blocks in which the planing-tools are fixed, as before explained. E is a pinion, which works in the toothed rack *f* on the under side of the central longitudinal beam of the platform B. F is a shaft, to one end of which the pinion E is fixed. G is a ratchet-wheel, near to the opposite end of the shaft E. H H is a pall and crank attached to a cross shaft, supported by the standards *l l*, which acts on the ratchet-wheel G. I is a pin, fixed in the side of the traversing-frame L L, and which, as that frame moves towards the side G*z*, catches the upright arm of the crank H, and presses it forward in that direction. K is a wheel, which, operating through the intervention of the shaft F, pinion E, and rack *f* on the platform B, throws it entirely back when all the stones upon it have been planed, or returns it under the planing tools if any part of the work requires to be gone twice over.

The *mode of operation* requires but little additional explanation. The platform being filled with blocks of stone, the vertical blocks *m m* are so adjusted that the roughing tools shall strike each block of stone as it passes under them, at such a depth below the top surface, as to sever and throw off before them large portions of the stone at a time, taking care always that the depth shall be within such limits as that the line of least resistance shall terminate in the top surface of the stone, so that the fractures shall all tend in that direction. When this adjustment has been made, the sliding-frame L L is to be moved towards H *x*, and as it traverses in that direction the sliding-rack W W carries the cross-beam Y Y in the same direction, until the connecting-rods Z Z have drawn the cant-blocks over as far as the screw *t*, when the roughing tools i^1 and k^1 will be brought into operation against the stone, and so continue till the projecting stud or catch S^1 comes in contact with the crank R, and throws the clutch off the pulley then in operation on to the other pulley, which will make the frame return in the opposite direction G*z*. The sliding-rack W W carries back at the same time the cross beam Y Y, till the connecting-rods Z Z push the cant-blocks over against the screw *u*, when the tools i^1 and k^2 are brought into play, and so continue till the catch S^2 comes in contact with the crank, and again reverses the motion. At the moment of this last reversal of the motion taking place, the projecting pin I also throws over the upright arm of the pall and crank H H (in a manner similar to the yard-beam of a power-loom), and brings

Fig. 3.

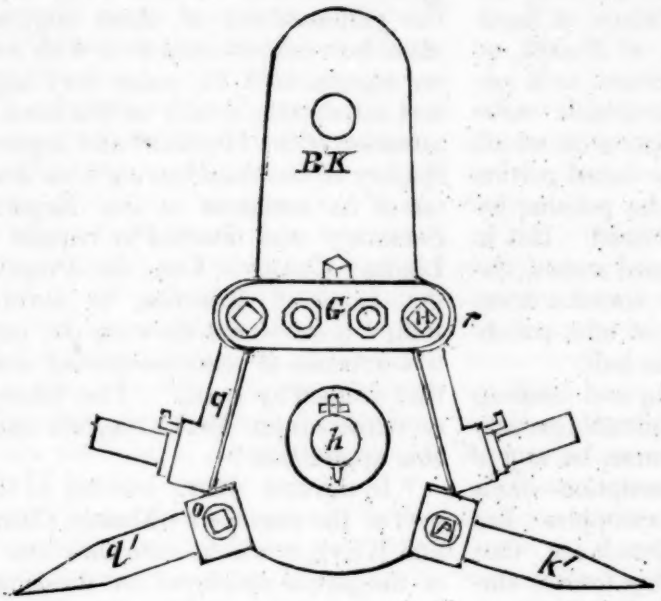
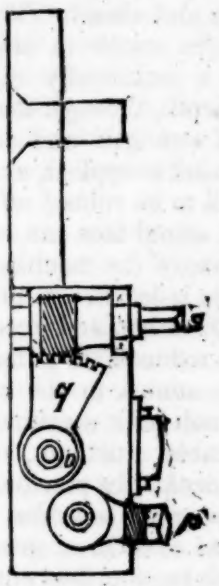


Fig 4.



forward the platform B with the stones for the next operation of the planing tools. The pall and crank H H falls back of its own weight into its former position, as soon as the pin I recedes from it. When the roughing tools are first brought into action, through the traversing of the frame L L towards H *x*, they commonly leave the surface of the stones in ridges, but the finishing tools being farther back, take off these ridges when returning, and so on till the planing of the blocks is completed.

No time is lost in clearing the platform of the finished blocks, as the men in attendance on the machine are removing the blocks at one end while the machine is at work at the other, and a minute or two suffices to return the platform. The frame L L generally traverses at the rate of 30 feet per minute, and a set of stones filling the platform from end to end, can be planed in about 45 minutes. As each tool wears it can be readily removed for the purpose of being repaired, or replaced by new tools by loosening the adjustings-crews *p p*.

The master feature of the invention appears to us to consist in the means provided for so adjusting the roughing tools (which have the roughest part of the work to perform), that they shall strike the blocks of stone as they pass under them, not *upon* the surface, as usual, but at *such a depth below it*, that the surface is driven off in large portions at a time. Not only are two or three tools thus able to do the work of a great many,* but the tools have time given them between each stroke to cool; or, to speak more properly, the strokes are made at such intervals that the tools never get sufficiently heated and softened to lose their original tempering. And hence this somewhat paradoxical consequence, that *the greater the thickness of surface which the tools have to cut away, the greater will be their efficiency, and the less they will be injured;* for the lengths of stone driven off at each stroke will always be proportional to the depth of the cutting, and the rest given to the tools in exactly the same ratio. We are informed that, in point of fact, the wear of iron is less by one-half in taking off two inches at a time than in taking off half an inch.

Another valuable though subordinate feature of the apparatus, is the ingenious manner of securing the tools in their places —the union of absolute fixedness while in operation, with the greatest facility for removing them as they are worn out and required to be repaired or replaced. The shaking or recoil after each stroke of the tools is stated to be so small, as to be hardly perceptible to the eye.

An important consequence of the equability of the force applied to the tools is, that the facing given to the stones by this

*In a stone-planing machine lately patented, the capabilities of which were much talked of for a time, there were no less than from 30 to 40 tools, to be applied in rapid succession to the stone.

machine is much smoother and sounder than any facing which can be given by the mallet and chisel. The surface of hand-wrought stones is always so bruised, or, what is technically called *dazed*, to a certain depth, through the unavoidable varieties of strength and direction with which the chisel is applied, and this dazed portion has all to be rubbed off by the polisher before a sound face can be obtained. But in the case of the machine-planed stones, the surface is left in so nearly sound a state, that the labor and expense of after-polishing is reduced more than one half.

The stones, to the cutting and dressing of which this machine is advantageously applicable, must not, of course, be any of an exceedingly precious description—none of the rarer marbles for examples; but such as exist in so great abundance, that an inch more or less cut away from a surface is of no consequence, and such too as acquire their chief value from the labor bestowed on extracting them from the quarry, and dressing them for use. The sorts of stone to which the patentee considers it to be most applicable, are sandstones, limestones and freestones, in all their varieties.* The power and velocity requisite vary considerably, according as the stone is soft or hard. Thus, for example, the Arbroath, which is a sandstone of very close and firm grain, admits of a degree of speed many times greater than some of the softer sandstones; and requires a power just so many times less. Again, stone harder than the Arbroath would require both the strength of the machine and the power of the steam-engine to be proportionally increased.

During the last summer there were six of these machines at work in the Leysmill Quarries, which planed upwards of 170,000 feet of pavement. They are worked by one steam-engine of 6 horse power, which has to work besides two inclined planes, up one of which the stones are dragged from the quarry to the machines.

*We are authorised by the patentee to state, that if any proprietor or lessee of a quarry, who may be desirous of trying the applicability of the machine to any particular species of stone, will forward a block of it in a rough state (carriage free) to Mr. Hunter (Leysmill, near Arbroath,) it will be returned to him planed and polished, along with an accurate report of the time occupied in the work, power applied, wear of tools, &c. Or, parties sending to Mr. Hunter two blocks capable of being turned into vases, according to patterns or drawings sent therewith, will receive in return one vase along with a report, &c. free of charge.

We have before spoken of the Report of Messrs. Carmichael and Kerr, C. E., on the performances of these engines, and must here content ourselves with referring our readers to it for some very important and satisfactory details on this head. The attention of the Highland and Agricultural Society of Scotland having been drawn by one of its members to this Report, their Secretary was directed to request W. F. Lindsay Carnegie, Esq., the Proprietor of the Leysmill Quarries, to favor them with "a statement showing the comparative expense of machine-dressed stone and that dressed by hand." The following is an extract from Mr. Carnegie's answer to this application:—

"In the first place, looking at the Report of the engineers (Messrs. Carmichael and Kerr), it will be seen that the wages of the people employed in dressing 4,400 feet, amounts to 6*l.* 15*s.* 6*d.*; this includes the wages of all employed in laying on, dressing, turning and taking off the stones, and also the wages of a person employed in repairs and the construction of additional machinery. To the above may be added for coals 15*s.* (our local situation enhances this item considerably), and for interest of fixed capital, and wear and tear about 2*l.* The calculation will then stand thus:—

Wages	6*l.*	15	6
Coals	0	15	0
Interest	2	0	0
4,400 feet, at	9	10	6

about four-tenths of a penny per foot. It is more difficult to state what the exact cost of dressing the same stones by hand would amount to. I may say, however, with perfect safety of being within the mark, that the stones in question could not have been dressed by hand at less than four times the cost by the machine, and that this is rather below than above the ordinary rate of difference.

"It was purposely left to the engineers to take their choice of any of the machines as they found them in the ordinary course of working, no notice having been given to the men, nor any preparation made.—As it happened, the stones in hand came from one of the most indifferent strata of the quarry, and the results shown came proportionately below the usual average.

"Had it been thought desirable to show off the machine to the greatest advantage, it might easily have been done, and without the slightest deception, very different results might have been brought out.—Thus, on account of their great weight, large stones, such as landings, grave-stones, &c. are previously squared in the quarry; when laid on the level, therefore, they fill accurately all the space the machine traverses.

"Suppose such a stone, 12 feet long by 6 broad, and 8 1-2 inches thick, and that it were required (an ordinary case) to be reduced to 7 inches in thickness. I am quite safe in saying, that the machine will do this in forty minutes, leaving the surface so smooth, that 9*d.* in hand-labor would bring the 72 feet to a perfect polish.

"Estimating as above the cost of working four machines for sixty hours at 9*l.* 10*s.* 6*d.*, forty minutes of one machine would amount to 6*d.*, but say an hour or 9*d.* as the cost of hewing 72 feet by the machine, that is about one-eighth of a penny per foot.

"To bring the stone to the same state by hand, the mason would require to go over it with four operations. He would, to speak technically, 1st, 'dab it over rough with a puncheon;' 2d, 'broach it close with a puncheon;' 3d, 'scabble it with a chisel;' 4th, 'angle drove it for polishing.' In this state, in consequence of the bruising operation of his chisel on the face being greater than that by the machine, it would cost twice as much to polish it.—The cost of the above four operations, at the lowest estimate, would be 2 1-2*d.* per foot. Thus the cost of hewing by hand and by machinery, would, in this case, be as 20 to 1.

"In estimating the outlay by the machine, ample allowance is made for the handling of the stones, the chief expense in the wages of the extra people attached to the mill, while nothing is charged for the assistance the mason would undoubtedly require in setting up and moving this stone. If this were taken into account, it would go far to double the comparative difference."

After receiving the above information, the Society thought the matter one of so much public importance, that they appointed a Special Committee of their number to repair to Leysmill, to "examine the machine in operation," and report the result of heir personal examination. The Committee consisted of the following gentlemen:

Lord Panmure.
Mr. Carnegie, of Craigo.
Mr. Hawkins, of Dunnichen.
Mr. Millar, of Ballumbie.
Mr. Proctor, of Halkeston.

This Committee paid a visit to the quarries, accordingly, on the 29th of June last, and the following is their report to the Society:—

"With reference to the statements contained in a letter of date the 10th day of June current, from Mr. Lindsay Carnegie to the Secretary of your Society, your Committee are convinced that these statements are fully borne out, and beg to submit the result of their own observations—the following facts:—

"There were put upon the bed of the machine at the same time, three pavement-stones, in a rough state, and of unequal thicknesses, the first of which contained 12½ superficial feet, requiring to be reduced two inches in thickness; the second, containing 16½ superficial feet, requiring to be reduced three quarters of an inch; and the third, containing 18 superficial feet, and requiring to be reduced one inch and a quarter; the whole of which stone, amounting in all to 47 superficial feet, were reduced and polished in thirty minutes, including in this the time occupied in shifting the irons.

"Your Committee beg further to state, that with a view of comparing the working of the machine and hand labor, they interrogated Mr. Donald Mackay, master mason and builder, in Arbroath, who stated that to have accomplished the same work in the ordinary way by the hand, would have occupied a good mason five days and a half, at a cost of 15*s.* 9*d.*, according to the present rate of wages in this part of the country; whereas, according to calculations submitted by Mr. Lindsay Carnegie, and which your Committee have every reason to believe correct, the expense would amount to about 1*s.* 7*d.*

"In addition to the trial above noticed, your Committee saw stones, of the hardest quality, from different quarries in the country, dressed by the machine with a corresponding advantage; and your Committee cannot close this report without expressing their conviction of the great advantages to be derived from the extended operation of Mr. Hunter's machine, as being the means of preparing for the market as pave-

ment, a quality of stone, which, without its assistance, could never be turned to account, as also the great saving to be obtained by its application to this hewing and dressing of all sorts of freestone.

"Your Committee beg leave also to report, that by the same steam-power they saw in operation the same principle applied as an experiment to a turning machine, from which they are satisfied that it may be applied with economy and advantage to the turning of stone vases, and other ornamental work."

"Leysmill, June 29, 1835."

The concluding passage of the preceding Report recalls to mind that we have yet one of the most valuable properties of this machine to notice—namely, that besides facing and dressing blocks of stone, it can be made (with the help of a lathe coupled to it) to turn, bore, and hollow them as well. Columns, ballisters, vases, drilled chairs and sleepers for railways, &c., may all, by this machine, be produced with a degree of accuracy, despatch and economy, wholly unattainable by hand labor. We mentioned in our notice of the last Meeting of the Institute of British Architects, (vol. xxiii., p. 349), one remarkable proof of this, which Mr. Carnegie presented to that Society, namely, a handsome vase turned out of the solid block, in the course of a single day's work, twenty inches high, and eighteen across the mouth. But this is nothing, we find, to what Mr. Hunter is making preparations to accomplish in the course of next winter's leisure. He talks with great confidence of being able to produce vases four feet high!—exact copies of our finest antiques, in all but the ornamental tracery, which must still remain to be done by hand. Of the ease with which holes might be drilled in stones by such combined machinery, the following extract from a letter, which we have seen from an eye-witness, furnishes equally striking evidence. He is describing a first trial in boring made by Mr. Hunter. "The stone," he says, "was old quarried and of the hardest yolk, and 5½ inches thick, the bore 1¾ inch diameter, and the time in going through the stone was exactly 2½ minutes; *it ran through it like wood.*"

The Arbroath stone on which Mr. Hunter's machines have been hitherto chiefly employed has been long in great request for foot-pavements, market-places, kitchen floors, &c.; and now that it can be produced by means of machinery in any quantities, will probably become still more and more so. It possesses this great advantage over the Yorkshire flag, that it resists the damp much better and dries more quickly; while it is, at the same time, equally cheap. In this point of view it has but one rival, the Caithness flag, to which however it is, in uniformity and homogeneousness of texture, vastly superior. In Scotland this species of stone, painted and varnished, is now getting into extensive use as a substitute for marble; it is a great deal more durable than Scagliola, and not half so expensive.

WINDMILL SHIP.—The *Biblioteca Italiana* mentions, that one Guiseppe Bruscetti, an engineer, has constructed a ship which is propelled in the manner of a windmill. "The vessel has two paddles like a steamboat, and the mechanism of the windmill is so contrived, that if there is any wind at all, from whatever quarter it may blow, the vessel is propelled by the action of the sails, and may be steered in whatever direction is desired." We suspect that this is but an Italian resuscitation of some of the many schemes of the same kind which have been broached in England—two or three of them in our own pages. If Signor Bruscetti will consult our 16th vol., p. 65, he will see what he has to expect, should he ever attempt to carry his ideas into practice on a large scale.—[London Mechanics' Magazine.

BRUSSELS RAILWAY.—The projectors of this Railway took credit for 100,000 passengers only, as the number that would avail themselves of it in travelling between this city and Antwerp; but although it has not been opened more than five months, the number already exceeds 200,000.—[Brussels Paper.]

From the London Mechanics' Magazine.

SOWERBY'S PATENT IMPROVEMENTS FOR SECURING SHIPS' WINDLASSES.

Sir,—Many nautical men having complained of the want of publicity of many patent windlass in some of the distant ports, whilst it is being so generally adopted and appreciated in those where it is known, I

will feel obliged by your inserting the accompanying description of its construction, action, and advantages, in your widly-circulated and valuable Magazine. As the safety of both life and property, as well as the quick performance of the voyage, so often depends upon the security and efficacy of a ship's windlass, improvements in its construction are of great importance to all connected with shipping, and, consequently, to a numerous class of your readers; to such the following may be found interesting, and for them it is more particularly written, by

Yours respectfully,
THOMAS SOWERBY.

Patent Windlass Works, near Shadwell Dock Basin, London, Oct. 7, 1835.

Fig. 1 is a section of the windlass body and side-view of the iron cylinder, which is firmly wedged thereon, with part of the flange broken off, to show the position of the patent iron pall and riding-chock when riding at anchor. The pall and riding-chock are each made on the segment of a circle, with teeth on their concave sides, corresponding with the teeth on the cylinder.

Fig. 2 is a front view of the same, and part of the windlass body; also of the wedge bolt, which is inserted above the pall to lock it when riding. The pall-plate is bolted to the pall-bit, and has a bolt passing through its flanges, by which the pall is guided when working. The shoe or deck plat is also bolted to the pall-bit, and, through a timber, to the deck, and has a bolt through its flanges for guiding the riding-chock, also a slit parallel with the deck for guiding the bolt passing through the wood or riding-chock wedge.

Action and Advantages of the Patent Pall.

Before getting the anchor, the riding-chock is ungeared from the cylinder by driving out the wood-wedge by a short crow or lever, and the lock-bolt is withdrawn from above the pall. When the windlass is hove round, the pall rises and falls perpendicularly in the succession of the teeth on the cylinder, thus palling at once every tooth on nearly a quarter of its circumference. It thus offers a more solid resistance than a series of palls, such as have been commonly used, and which are shown at fig. 3, and its action against the pall-bit is much nearer to the deck. It cannot possibly trip or be upset, as, from its wedge-like form, it becomes but more firmly fixed as the strain increases. Neither is it injured by screwing or otherwise straining the deck-timbers, but fits alike, however the windlass is raised or depressed; on which account it has proved particularly valuable to ships carrying wool, hemp, and other screwed cargoes, from many of which the common palls had been taken out. If the cable ride, or a hand-

Fig. 1.

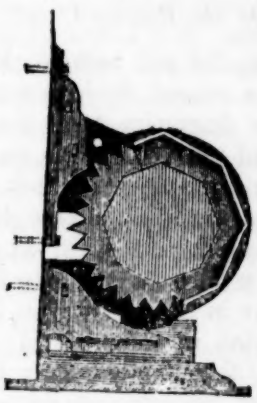


Fig. 2.

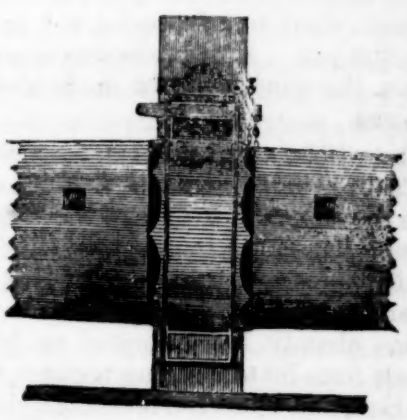
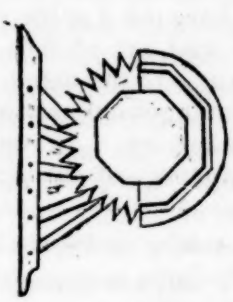


Fig. 3.



spike foul, the windlass may be immediately run backward by lifting the pall. It si always in full pall, and to meet a sea, or for riding or veering the cable, it may be instantly converted into an efficient riding-chock by inserting the lock-bolt, which effectually prevents the windlass from being moved either way.

Of the Riding-Chock.

For riding, the pall being locked, the riding-chock is raised by a lever, and the wood-wedge driven in until the chock is firmly geared with the teeth on the cylinder. By this simple and quick operation, the windless becomes a complete fixture with the pall-bit and deck, which cannot be removed whilst they remain fast, as it is secured alike in every direction, being literally embedded in iron. It is so readily applied, that the windlass may be chocked or unchocked instantaneously, and at any time, as the pall and chock fit alike to every part of the cylinder. It does not strain the windlass from the pall-bits, like the common wood riding-chocks, but supports it to the pall. It occupies less space, and allows the windlass to be made shorter, if required.

The whole apparatus can be applied to any ship windlass, and at a less expense than the common palls and the wood riding-chocks. It is more easily fitted, and not liable to get out of repair; and is peculiarly adapted to the use of chain cables. It has already been adopted on board of vessels from 30 to 960 tons register, including East and West Indiamen, English and foreign traders, steam-packets, cutters, &c.; and the reports of the many intelligent and experienced commanders who have it in use, and who have put it to the most severe and complete trial, are at once gratifying and conclusive as to the many great and important advantages it possesses. In short, all agree in allowing it to combine compactness, cheapness and security.

From the Journal of the Franklin Institute.

MR. HERRON'S IMPROVEMENTS IN RAILROAD CARS.

(Extracted from the List of American Patents which issued in March, 1835.)

54. For improvements in *Railroad Cars*; James Herron, Civil Engineer, Richmond, Henrico county, Virginia, March 25.

There are several distinct improvements claimed by this patentee, all of which are described in a very full and clear manner, and illustrated by drawings, which leave nothing to desire on this point; it will appear, however, upon examining into the originality of the things claimed, that they are generally old, and have been fully described in this journal, or elsewhere in public works. The following are the claims.

"*Specification* 1*st*.—In this I claim as being the original inventor of carriages adapted to run alike on the edge railway, and on turnpike roads, as hereinbefore described.

"*Specification* 2*nd*.—In this I claim as being the original inventor of the *roller flanches* for retaining and guiding carriages on rail-roads, as hereinbefore described.

"*Specification* 3*rd*.—In this I claim as being the original inventor of the plans hereinbefore described for making the carriages conform to the curves on the railway.

"*Specificaion* 4*th*.—In this I claim as being the original inventor of the *friction head*, for reducing the friction of axles, as hereinbefore described.

"*Specification* 5*th*.—In this I claim as being the original inventor of the *friction band*, for reducing the friction of axles, as hereinbefore described.

"And I distinctly claim the right to apply my improvements, or inventions, herein specified and described, in whole or in part, as the nature of the case may require, to all carriages, cars, wagons, locomotive engines, and other machines."

The thing claimed in the first specification, which is for adapting the wheels to run on common roads, was the subject of a patent obtained by Samuel T. Jones, of Philadelphia, on the 22d of February, 1830; see vol. v., page 151; and also of one obtained by Mr. John pollock, on the first of October of the same year. The present patentee uses wheels of five feet in diameter, with a flat tread, and without the usual flanch, instead of which "there is placed alongside of each wheel a flat disk of iron, which I term a *roller flanch*, as it is at liberty to revolve on its own axis, entirely independent of the burthen wheel;" "when the carriages are used for streets, the roller flanches are raised up to the position represented by the dotted circle." Mr. Jones, in his specification, above referred to, says, "I sometimes make my wheels without

flanches, and, instead thereof, use friction rollers, fixed upon, or adapted to, suitable arms, or bearings, extending down to the rail, so that the rollers may bear against its side, and perform the office of a flanch." "I construct them so that they may slide up, when the car, or carriage, is about to pass off the railroad."

The plans claimed for making the carriages conform to the curvature of the railway are two, both of which require that the axles of the fore and the hind wheels should have their bearings on separate rectangular frames, which allow the axles to move from their parallel position, like those of common carriages, by means of the hounds; but in the case before us both frames turn, they being "connected by means of the coupling bar at a point intermediate between the axles, to which bars are attached toothed segments, adapting each pair of wheels equally to the curvature of the road."

By turning to vol. iii. p. 66, it will be seen that the late Dr. Wm. Howard obtained a patent, dated Nov. 22d, 1828, for the application of this principle, which he states in the following words: "The connexion of the two beds of the axles at a point equidistant from each; and in the same manner the connexion between the hind bed of ene wagon, and the fore bed of that following it, or the fore bed of the leading wagon with any system of guide wheels, so that the wheels not only of one wagon, but of a train, will follow one another in the same curve, without more lateral friction than when on a straight line." This description is accompanied with plates, to which the reader may turn, and see a full exemplification of the principle.

Under this same head, Mr. Herron refers to a method of using jointed crossbars, instead of the circular segments, by which "the same object will be more simply effected." by turning to the patent of Mr. John Pollock, obtained October 1st, 1830, this coupling by jointed crossbars will be found represented in a drawing, together with several other things which the present patentee deems to be new, and among them the making the wheels without flanches, that they may run upon common roads; see vol. vii. p. 17.

The "friction bands," mentioned by the patentee as claimed under his fourth specification, are hoops, or rings, of iron, by means of which the carriage frames are suspended below the axles of the burthen wheels; these hoops pass over the prolonged ends of the axles, and under friction rollers upon the frame of the carriage, and are to roll around by the friction of the axle upon them, in the manner, though not for the purpose, of Winan's friction wheels. It will be found in practice that these hoops will frequently stand still, and allow the axle to turn within them, as has often been the case with Winan's wheels, which have in several instances been cut through by this means. Besides this, the idea of suspending the load upon revolving rings is not new; N. Finlay, of Baltimore, suspended the load in this way; see the notice of his patent, dated October 27th, 1829, at p. 36, vol. v.

The cranked axle mentioned in the fifth specification is intended to allow the load to extend below the axis of the load wheel. This has been effected by Samuel T. Jones, in a car patented by him, and described, vol. v., page 149; it has also been effected by others. We could have cited other authorities, also in most of the cases above noticed, with some of which we opine that it would be well for civil engineers to make themselves acquainted.

BACHMANN'S FRAME FOR RAILROAD CARS, AND OTHER CARRIAGES.

(From the List of American Patents which issued in May, 1835.)

4. For an improved *Frame for Railroad Cars, and other Carriages;* Heinrich Bachmann, Lancaster, Pennsylvania; an alien who has resided two years in the United States: May 2.

We are informed that by the plan here proposed, Railroad Cars may turn the small curves necessary in leaving the track for a warehouse, a yard, &c.; and that the lateral friction on the rails will be no greater upon any curve than on a straight line. We wish that this was true, but, unfortunately, the theory of the patentee is incorrect, and the plan by which he proposes to produce this useful effect is without novelty, its essential principle being well known, and repeatedly patented. The plan for causing the fore and hind wheels to adapt themselves to a curve, simultaneously, is the same with that upon which we remarked at p. 249, when speaking of Mr. Herron's pa-

tent, and to which, in order to avoid needless repetition, we must refer the reader. As regards the correctness of the theory, let it be remembered that when the fore wheels of a car pass from a straight road on to a curve, the hind wheels are still upon the former, and that by the plan proposed they are adapted to a curve at which they have not yet arrived, and will, therefore, have to grind their way to it. The patentee proposes to place the hind and fore wheels ten feet apart, which will greatly augment the evil that he imagines he has removed.

As in turning curves the opposite wheels must move with different velocities, the patentee uses a separate axle to each wheel, thus admitting of this difference of motion; there is no more novelty in this than in the other parts of the plan. Separate axles have been repeatedly used; and the same effect was produced, many years since, by leaving one wheel on each axle loose, so that, when necessary, it could turn upon it in the ordinary way.

34. For *Increasing the adhesion of the hind wheels of Locomotive Engines*; Chas. and Geo. Escal Sellers, city of Philadelphia, May 22.

A patent was obtained by Mr. E. L. Miller, on the 19th June, 1834, for a method of obtaining a similar end, by throwing the weight of a car, or tender, on to the hind part of a locomotive engine. The present patentees effect the object by "so coupling, or connecting the cars containing the load to be drawn, to the body of the locomotive engine, as that the load by its action upon a lever, or standard, shall tend to raise the fore end of the locomotive, in any desired degree, and thus to lessen the pressure upon the fore, and transfer the same to the hind wheels."

The patentees say that they "do not mean to limit themselves to any particular form or manner of constructing the parts concerned in producing the intended effect, but claim as their invention the connecting to a Locomotive Engine, the load which is to be drawn by it, in such a manner as to throw a larger portion of the weight of the locomotive upon its hind wheels than they are ordinarily intended to sustain, in the manner, or upon the principle herein before set forth."

It will be readily seen that the coupling bar, or jointed rod, by which the car is attached to a locomotive, if attached to it at a point considerably above that by which it is attached to the car, will tend to lift the latter, and to draw down the former, and thus to increase the adhesion of its hind wheels.

35. For an improvement in *Mills for Sawing Stone*; Joseph L. Dutton, city of Philadelphia, May 22.

This patent is taken for the particular construction of the building in which the sawing is to be effected. In the first place, the floor of the mill is to be raised to such a height from the ground "as to be on a line with the bed of the log or marble teams, by which means most of the expense incurred by unloading, and reloading, is saved." On this elevated floor are placed several short transverse railways, upon which run cars to which the blocks of stone are transferred, immediately from the common teams, and by which they are supported during the operation of sawing.

Above the before mentioned railways, the framework of the building supports other railways, upon which also there is a car furnished with a screw, by means of a chain dependent from which, a block of marble may be suspended and transferred to any part of the mill where it may be wanted. A crane is likewise constructed, which sustains a car similar to that last described, for aiding in the transfer of the stone from one part of the building to another. The arm of this crane is supported upon friction wheels, running upon a suitable curved way, erected for that purpose.

"I claim an exclusive right to the raising of the mill floor, as above described. The traversing car. The application of the upper car to saw mills. The crane, whether applied to saw mills, or for any other purpose; and the regulating spring of the saw slides."

We think that the foregoing claim is very susceptible of improvement. The mere raising of the floor, for the purpose pointed out, we do not think new in saw mills, for we err greatly if we have not seen, in Philadelphia itself, a mill, for sawing mahogany, with the floor so raised "as to be on a line with the bed of the log" carriage. Nothing is said about any novelty in the traversing car which is to receive the stone, nor do the upper cars

differ from such as have been used for raising and transferring loads, for other purposes. The crane is claimed, "whether applied to saw mills, or for other purposes;" now this assuredly does not mean a crane generally, yet we are not told in what particular this crane differs from others; a thing that should not be left to be inferred, but which ought to have been particularly specified. The fact is, that the novelty and utility of the structure consist not so much in the formation of its individual parts, as in the general arrangement and combination of the whole, by which it is adapted to the attainment of the object proposed, and upon this the claim to invention must mainly rest.

For the Railroad Journal.

ON THE MANUFACTURE AND USE OF SOLUBLE GLASS.

Translated from "Traité de Chimie appliquée aux Arts, par Mr. Dumas," by JAMES RENWICK, L. L. D., Prof. of Nat. Exp. Philosophy and Chemistry in Columbia College, New-York.

Soluble glass is a simple silicate of potassa or soda, which unites perfect solubility in boiling water to some of the general properties of common glass: besides, although the uses to which soluble glass is applied are very different from those of common glass, the study of it will furnish such exact and close analogies to other descriptions of glass, that we are compelled to include it in the groupe of chemical compounds which they form.

The discovery of soluble glass and of its uses, is due to a distinguished German chemist, from whom we derive all we have to say in relation to it. This glass, when dissolved in water, forms a liquid which may be applied to cloth or wood, for the purpose of rendering them incombustible. In fact, by the evaporation of the water in which it is dissolved, a layer of a substance capable of fusing when heated, is deposited on these bodies, which is capable of protecting them from the contact of air necessary for their combustion.

Preparation.—Soluble glass may be obtained by dissolving pure silea, obtained by precipitation, in a boiling solution of caustic potassa; but, this process being both inconvenient and costly, cannot be practised upon a large scale.

When sand and carbonate of potassa are heated together, the carbonic acid is never wholly driven off, except when the sand is in excess; but the whole of the carbonic acid may be expelled by adding powdered charcoal to the mixture, in such proportion that the carbonic acid of that part of the carbonate which is not decomposed may meet with a sufficient quantity of carbon to convert it into carbonic oxide. In this way the silica first forms a silicate in the proportions contained in common glass, and drives off the appropriate equivalent of carbonic acid; then, at a high heat the rest of the carbonate of potassa is decomposed by the carbon, the carbonic oxide escapes, and the potassa thus freed, either sublimes, or combines with the glass already formed.

In order to obtain soluble glass of good and uniform quality, certain precautions are necessary. The carbonate of potassa employed, must be purified.* If it contain much chloride of potassium, the product will not be entirely soluble in water, and a glutinous residuum will be left. In addition, the glass will be liable to effloresce. Sulphate of potassa does not produce any bad effect, because it is decomposed by the carbon, when the matter continues sufficiently long in fusion, but without this precaution the glass will contain sulphuret of potassium, which also has a tendency to effloresence.

The sand must be pure, or at any rate must not contain any notable proportion of lime or alumina, for these earths render a part of the glass insoluble. A small portion of oxide of iron has no influence on the qualities of the glass.

The sand and carbonate of potassa (pearlash) are taken in the proportion of two of the latter to three of the former, and to 10 parts of pearlash and 15 of sand, 4 parts of charcoal are added; a less portion of charcoal must not be taken; on the contrary, if the form of potash employed be not sufficiently pure, a larger proportion of charcoal may be advantageously employed. This substance accelerates the fusion of the glass, and separates from it all the carbonic acid, of which there would otherwise remain a small quantity, which would have an injurious effect.

In other respects, the same precautions that are employed in the manufacture of

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* Pearlash being the purer form, we shall use its name in the practical part.

common glass, are to be observed. The materials must be first well mixed, then fritted, and finally melted in a glass pot, until the mass becomes liquid and homogeneous. The melted matter is taken out of the pot with an iron ladle, and the pot is then filled with fresh *frit*.

Thirty pounds of pearlash, 45 of sand, and 12 lbs. of powdered charcoal may be taken for a charge ; with this quantity the heat must be continued for 5 or 6 hours.

The crude glass thus obtained is usually full of air bubbles ; it is as hard as common glass, of a blackish gray color, and transparent at the edges ; sometimes it has a color approaching to whiteness, and at others is yellowish or reddish ; these are indications that the quantity of charcoal has not been sufficient.

If it be exposed for some weeks to the air, it undergoes slight changes, which rather tend to improve, than injure its qualities. It attracts a little moisture from the air which slowly penetrates its mass, without changing its aggregation or its appearance; it merely cracks, and a slight effloresence appears at its surface. If it be exposed to heat, after it have undergone this change, it swells up, owing to the escape of the aqueous matter it has absorbed.

In order to prepare it for solution in boiling water, it must be reduced to powder by stampers ; if this were not done, it would dissolve too slowly. One part of glass requires from 4 to 5 of water for its solution.

The water is first heated to ebullition in an open boiler, the powdered glass is then added by degrees, and must be continually stirred, to prevent it from adhering to the bottom. The ebullition must be continued three or four hours, until no more glass is dissolved: the liquor will then have acquired the proper degree of concentration. If the ebullition be checked before this state is attained, carbonic acid will be absorbed by the potassa from the air, which will produce an injurious effect ; for the same reason, too great a quantity of water must not be employed, for during the long evaporation which will then become necessary, the carbonic acid of the water will readily combine with the potassa, and cause a precipitation of the silica.

When the liquor becomes too thick, before the whole of the glass is dissolved, boiling water must be added.

When the solution has acquired the consistence of syrop, and a density of 1.24 to 1.25, it is sufficiently concentrated and fit for use. It is then permitted to rest, in order that the insoluble parts may be deposited ; while it is cooling, a coriaceous pellicle forms upon the surface, which after a time disappears of itself, or may be redissolved by depressing it in the liquor. This pellicle begins to appear during the ebullition, as the liquor approaches a state of concentration, and may even serve to indicate this state.

When the crude glass is of a proper composition, contains but few saline impurities, and no sulphuret of potassium, it may be treated in the way we have described. But if it contain any notable proportion of these substances, they must be separated before it is dissolved ; this separation may be effected in the following manner. The powdered glass is exposed to the action of the air for three or four weeks, during which time it must be frequently stirred ; if it run into lumps, which will happen in moist weather, they must be broken up. The glass, as we have stated, attracts moisture from the air, and the foreign substances either separate or effloresce. It then becomes easy to remove them from the glass. It is sprinkled with water, and frequently stirred. At the end of three hours the liquor is removed, it will then contain a part of all the saline impurities, and a little of the silicate of potassa ; the powder is again to be washed with fresh water. Soluble glass thus treated, readily dissolves in boiling water, and the solution leaves nothing to be desired.

As soluble glass is employed in the liquid form alone, it is kept in this state for use. To preserve it, no particular care is necessary, as even after a long space of time it undergoes no perceptible change, if the solution have been properly prepared. The only precaution is not to allow air too free an access to it.

A similar product may be obtained by using a carbonate of soda instead of one of potassa. In this case, two parts of the soda of the shops is required for one of silica. This glass has the same properties as the other, but is more valuable in its uses. The solutions of these two kinds of glass may be mixed in any proportion whatever, and this mixture is more serviceable in some cases, than either of them separately.

Properties.—Soluble glass forms a vis-

cid solution, which when concentrated becomes turbid and opalescent ; it has an alkaline taste and reaction. The solution mixes in all proportions with water. When the density of the solution is 1.25, it contains nearly 28 per cent. of glass ; if the concentration be carried beyond this point, it becomes so viscid that it may be drawn out in threads like molten glass. Finally the liquor passes to the state of a vitrous mass, whose fracture is conchoidal ; it then resembles common glass, except in hardness. When the solution is applied to other bodies, it dries rapidly at common temperatures, and forms a coat like a varnish.

Soluble glass when dried, does not undergo any perceptible change when exposed to the air, and attracts from it neither moisture nor carbonic acid ; neither has the carbonic acid of the atmosphere any well marked action on the concentrated solution; but when a current of carbonic acid is passed through the solution, the glass is decomposed, and hydrate of silica deposited. But a weak solution becomes turbid on exposure to the air, and is after a time decomposed wholly. When the glass is impure, an effloresence is formed after a while, which may be produced either by the carbonate and hyposulphite of potassa, or by chloride of potassium.

Soluble glass dissolves gradually without residuum in boiling water ; but in cold water the solution is so slow as to have led to a belief that it does not dissolve at all. It however never becomes entirely insoluble, except when it contains a much larger proportion of silica, or when it is mixed with other bodies, such as the earths, metallic oxides,&c. with which double or triple salts are formed, as is the case in the common glasses.

Soluble glass which has been exposed to the air, and is afterwards submitted to the action of heat, swells and cracks at first, and melts with difficulty. It then loses about 12 per cent. of its weight. It therefore contains, even when solid, a considerable quantity of water, which it does not lose when simply dried by exposure to the air.

Alcohol precipitates it unaltered from its solution in water. When the solution is concentrated, but little alcohol is required for precipitation, and it need not be highly rectified. Pure soluble glass may therefore be easily obtained from an impure solution by the use of alcohol. The alcohol being added, the gelatinous precipitate is permitted to settle ; the supernatant liquor is decanted, the precipitate collected, rapidly stirred after the addition of a little cold water, and subjected to pressure. In truth, however, this process is attended with some loss, for even cold water will rapidly dissolve the precipitated glass, in consequence of its minute division.

The acids decompose the solution of glass. They also act upon it when solid, separating the silica in the form of powder.

Uses.—The properties of soluble glass fit it for numerous and varied applications. It has been used in the theatre of Munich as a means of safety from fire.

All sorts of vegetable matter, wood, cotton, hemp, linen, paper, &c. are, as is well known, combustible ; but in order that they shall burn, two conditions are requisite, an elevated temperature, and free contact of air, to furnish the oxygen necessary for their transformation into water and carbonic acid. When once set on fire, their own combustion develops the heat necessary to keep up the chemical action, provided they be in contact with air. If deprived of such contact, and made red hot, they will, it is true, yield inflammable volatile products, but the carbon which is left will not burn, as it is deprived of air, and thus the combustion will stop of itself. Such is the part which all the fixed fusible salts are capable of performing, if they be in addition composed of substances incapable of yielding their oxygen at a low red heat, to either carbon or hydrogen. These salts melt as the vegetable matter becomes heated ; they form upon it a coat impenetrable to the air, and either prevent altogether, or limit its combustion. The phosphate and borate of ammonia have such a character, but they are so readily soluble in cold water, as to be liable to objections which cannot be urged against soluble glass.

Although soluble glass is of itself a good perservative from fire, it fulfills the object better when it is mixed with another incombustible body in powder. In this case the solution of glass acts in the same manner as the oil of painters. The several coats have more body, become more solid, and more durable, and if the substance which is added be of proper quality, coagulate by the action of fire into a strongly adhe-

sive crust. Clay, whiting, calcined bones, powdered glass, &c. may all be employed for this purpose ; but we cannot yet say with certainty which of them is to be preferred. A mixture of clay and whiting, appears to be better than either used separately. Calcined bones form with soluble glass a very solid and adhesive mass. Litharge, which, with the glass, makes an easily fusible mixture, does not give a product fitted for coating wood, as the mixture contracts in drying ; it therefore cracks, and is easily separated. Flint glass, and crude soluble glass, are excellent additions. The latter ought to be exposed to the air after it is pulverized, in order to attract moisture.— If it be mixed with the solution, and be then applied to any body whatever, it in a short time forms a coating as hard as stone, which if the glass be of good quality, is unalterable by exposure, and resists fire admirably.

The scoriæ of iron and lead, felspar, fluor, may all be employed with soluble glass ; but experience alone can decide which of these substances is best, and in what proportion they are to be employed. We should advise that the first coat should always be a simple solution of the glass ; and that a similar solution be applied over coats composed of its mixture with other substances, particularly when such a coat is uneven, and rough.

The last named substances form a solid and durable coating, which suffers no change by exposure to the air, does not involve any great expense, and is readily applied. But in order that it may not fail, particular care is to be taken both in preparing and employing it.

In order to cover wood and other bodies with it, the solution must be made of a pure glass, for otherwise it would effloresce and finally fall off. However, a small degree of impurity is not injurious, although after a few days a slight efflorenscence will appear ; this may be washed off by water, and will not show itself a second time.— When a durable covering is to be applied to wood, too strong a solution must not be employed at first, for in this case it will not be absorbed, will not displace the air from the pores, and in consequence will not adhere strongly. It is a good plan to rub the brush several times over the same place, and not to spread the coating too lightly. For the last coats a more concentrated solution may be employed, still it must not be too thick, and must be spread as evenly as possible. Each coat must be thoroughly dry before another is applied ; and this will take in warm and dry weather at least 24 hours. After 2 hours the coat appears to be dry, but is still in a state to be softened by laying on another. The same inconvenience will then arise, which occurs when a thick coat of a concentrated solution is applied ; the coast will crack, and does not adhere. This however is only the case when potassa is the base of the glass, for that formed from soda does not appear to crack.

In applying soluble glass to the woodwork of the theatre at Munich, 10 per cent. of yellow clay (*ochre* ?) was added. After six months, the coat had suffered but little change ; it was damaged only in a few places, where it had need of some repair. This arose from a short time only having been allowed for the preparation and application of the glass, and they were therefore done without proper attention.

When this mode is employed for preserving a theatre from fire, it is not enough to cover the woodwork, it is also necessary to preserve the scenery, which is still more exposed to danger. None of the methods yet proposed for this purpose appears as advantageous as soluble glass, for it does not act on vegetable matter, and completely fills up the spaces between the thread ; it fixes itself in the web, in such a way that it cannot be separated, and increases the durability of the fabric. The firmness which it gives to stuffs does not injure them for use as curtains, because it does not prevent them from being easily rolled. So far as the painting of scenes is concerned, the glass forms a good ground for the colors. To prevent the changes which some colors, Prussian blue and lake for instance, might undergo from the alkaline matter, it will be necessary before painting to apply a coat of alum, and then one of whiting.

There is no great difficulty in applying soluble glass to cloths, still this operation is not so easy as might at first be imagined. It is not sufficient to coat or dip them in the solution; they still require after this operation to be subjected to pressure. This object might perhaps be best attained by passing them between rollers plunged in the solution. When a cloth which is only coated with soluble glass, is put into the

fire, it will remain incandescent after it is taken out. This is not the case when it has been properly impregnated with the solution. A still better purpose is answered in this case, when litharge has been added to the solution. The stuff in drying yields to the shrinking of the mixture, and becomes inseparable from it, which is the reverse of what happens when it is applied to wood. A single part of litharge in fine powder is sufficient for 14 parts of concentrated liquor.

Soluble glass is capable of many other applications, and particularly as a cement; for this use it is superior to all those which have hitherto been employed, for uniting broken glass, porcelain, &c.

It may be used in place of glue or isinglass in applying colors, although when employed by itself, it does not make a varnish which will preserve its transparency when in contact with air.

Rochester Edge-Tools.—Among the various branches of business now in successful operation in the city of Rochester, none are more deserving of attention than the manufacture of Edge-Tools. To such perfection is this carried, that nearly all descriptions of the article can be furnished from our manufactories with a *finish* and at a *price* which are rapidly giving them a preference over the wares of Sheffield and Brummagem. Mechanics and others who use such articles have a deep interest in enconraging our own manufactories—as thereby they can have tools *warranted* of the first quality, while the encouragement bestowed on our own artizans promotes our domestic welfare, and aids in insuring an excellent supply at reasonable prices from our own workshops.

The Edge-Tools fabricated by Messrs. *Barton & Babcock*, are creditable to themselves and to the character of our mechanic arts. All who have used them concur in their praise. The manufactory is in the stone building at the southwest corner of the main bridge across the river. They employ about twenty-five hands, on an average—consume from 12 to 14 tons of iron, 8,000 lbs. cast steel, 500 lb. of borax, 30,000 bushels of charcoal, &c. Judging from the success of the experiment which they have already made, their business will soon be greatly extended, as the excellence of their manufactures becomes as generally known as it deserves to be.

We can bear willing testimony to the correctness of the encomium passed by "Rho," on the gentlemen and articles referred to in the above notice. We speak from personal observation and inspection—and would recommend them to the patronage of the public.—[Ed. M. M.]

Few Things Impossible.—"It is impossible," said some, when Peter the Great determined to set out on a voyage of discovery, through the cold northern regions of Siberia, and over immense deserts; but Peter was not discouraged, and the *thing was done.*

"It is impossible," said many, when they heard of a scheme of good Oberlin's. To benefit his people, he had determined to open a communication with the high road to Strasburg, so that the productions of de la Roche (his own village,) might find a market. Rocks were to be blasted, and conveyed to the banks of the river Bruche, in sufficient quantity to build a wall for a road along its banks, a mile and a half, and a bridge across it. He reasoned with his people, but still they thought it was impossible; but he seized a pickaxe, put it across his shoulder, proceeded to the spot, and went to work, and the peasants soon followed him with their tools. The road and bridge were at length built, and to this day, the bridge bears the name of the "Bridge of Charity."

"It is impossible," said some, as they looked at the impenetrable forests which covered the ragged flanks and deep gorges of Mount Pilatus in Switzerland, and hearkened to the daring plan of a man named Rupp, to convey the pines from the top of the mountain to the Lake of Lucerne, a distance of nine miles. Without being discouraged by their exclamations, he formed a slide or trough of 24,000 pine trees, 6 feet broad, and from 4 to 6 feet deep; and this slide, which was contemplated in 1812, was kept moist. Its length was 44,000 English feet. It had been conducted over rocks, or along their sides, or over deep gorges, where it

was sustained by scaffolds; and yet skill and perseverance overcame every obstacle, and the thing was done. The trees slid down from the mountain into the lake with wonderful rapidity. The large pines, which were one hundred feet long, ran through the space of eight miles and a third in about six minutes.

A gentleman who saw this great work, says :—"Such was the speed with which a tree of the largest size passed any given point, that he could only strike it once with a stick as it rushed by, however quickly he attempted to repeat the blows."

Say not hastily, then, ofany thing, "It is impossible." It may not be done in an hour, or a day, or a week; but perseverance will finally bring you to the end of it. "Time and patience," says a Spanish proverb, "will turn a mulberry leaf into silk."

Thames Tunnel.—We find in the London Mechanics' Magazine, for October, the following article in relation to this important work. We do not, however, learn from it the precise condition of the work, nor the prospect of its early completion, yet it contains other information in relation to the mode of performing the work, which may be of use to our readers, therefore we giv it at length.

THAMES TUNNEL.

Mr. Editor,—A correspondent of yours, G. L. S., in No. 632 of the Mechanics' Magazine—a well-wisher evidently to the success of this great enterprise, condemning with justice the angry feelings expressed by some of your contributors against it, as attributable to personal motives, gladly and liberally offers a suggestion for the greater security of the work while in progress.

He says, that "to sustain the pressure of the superincumbent earth, during the excavation, he would drive 18 inches apart, horizontally, before the shield, and in a line with the top of the brickwork, iron rods, 1 inch thick and 8 feet long, and that a sheet of iron one quarter of an inch thick should then be laid over every two of the rods; thus he would form over the shield a covering (or ceiling,) which would be moved forward when a yard of tunnel is finished."

Prompted, as he is, by a friendly disposition, it is presumed that he will be gratified by learning what the provisions of the engineer actually are for sustaining the pressure of the superincumbent earth, while the excavation is being made. He should first know, however, what the scale of the operation is.

The excavation made for the Thames Tunnel is about 38 feet in width, and 22 feet 6 inches in height, presenting, therefore, an opening exceeding 850 feet. The whole of this excavation, including its two sides, which may be computed at 400 feet, is secured by means of a powerful apparatus designated the shield, as is also the roof of it, which measures 350 feet. A full tide the weight of both earth and water, which constitute *the superincumbent pressure*, is not less than 700 tons. This is the portion that has formed the subject of your correspondent's solicitude.

The *ceiling* of the shield consists of 24 or 26 pieces of cast-iron, denominated staves, closely adjusted; and as they are sometimes made to relieve each other, and therefore subjected to an increased load, they are for greater strength made like inverted troughs of cast-iron; their breadth is 18 inches, the depth of their sides 7 inches, and their length 9 feet, independently of a tail of wrought-iron which overlays the brickwork. The edges in front are made sharp for entering the ground, and the external surfaces of the staves are planed very true. Similar staves are laid against the sides of the shield, all planed and equally well adjusted; each stave can be impelled singly as sheet piles are. Upon the whole the shield may be viewed as a coffer-dam, which, instead of being moved in a perpendicular direction, is placed and is impelled horizontally. The standing part of the shield consists of 12 parallel frames, all independent of each other.

The front of this vast excavation is protected in a different manner from that of the sides. It is panelled all over with small boards, each of which is 3 feet long and 6 inches wide. There are, therefore,upwards of 500 of these boards, technically called polings, for covering the whole face of the excavation. Every one of these polings is held in place, and secured by means of two hand-jacks or screws, abutting against the frames. There are, therefore, upwards of one thousand of these jacks in action for securing the face of the excavation, or, rather, for pressing against the ground with

sufficient power to prevent any disruption of its various strata; for were the ground to be at all deranged, the pressure against the sides and front of the shield might soon increase to 2,500 or 3,000 tons, independently of that of the superincumbent pressure.

It is further to be remarked, that every successive side, which at its full head is 76 feet above the foot of the excavation, causes an incessant variation in that pressure tending to strain the hard strata, and to soften or knead the intervening soft ones; a fact quite unnoticed by projectors of plans, but which proved fatal to those who attempted the drift-way under the Thames in 1808. The pressure exerted against the front of the excavation by the agency of the shield, must therefore be uniformly kept at a maximum. The shield is advanced only 9 inches at a time, while the brick structure proceeds simultaneously.

Your correspondent, influenced as he is by the best motives, will have great satisfaction in learning, that the new shield is now being made without the necessity for modifying any law of hydraulics, or changing the nature of the ground, as has been too much the case with the various projectors who have sought to labor in the same field with the engineer of the Thames Tunnel.

Those who, without considering what must first be done under-ground, conceive that every difficulty would be obviated by some particular covering laid on the bed of the river over the tunnel, such as timber-flooring, rafts, planking, roofing, plates of metal of any kind, tarpaulings, sails, leather, &c., loaded over with some great weight or not loaded at all, should further consider that they have, we are assured, upwards of 300 competitors for the same expedient, besides about 90 who, from motives of caution, have reserved the disclosure of their respective plans, until some renumeration should previously be provided.

It would be well if those who feel disposed to enter the List of Competitors, were first to consult the report of those miners who directed the attempts that were made and carried on with so much perseverance, between the years 1803 and 1808, with the ultimate object of opening a roadway under the Thames at Rotherhithe. These were miners (Cornishmen), engineers in that branch of the art, and, consequently, eminently qualified for the task in every respect; they were as sanguine, too, as any of the projectors of this day; and their excavation was limited, in the first place, to a simple driftway, the height of which was only 5 feet, the breadth 2 feet 6 inches at the top, and 3 feet at the bottom, forming, therefore, an excavation that was sixty times smaller than the excavation which has been made for the Thames Tunnel.—Diminutive, however, as this hole was when contrasted with that of the tunnel, the ground in the roof, though supported by substantial planking, gave way once in a fluid state, leaving an unsupported cavity over the roof of the driftway; still it held itself up; but a second accident of the same nature having occurred under a very high tide, the river broke the ground and entered the drift. In both cases it was the loose ground that forced its way first into the drift, and the river afterwards. The miners succeeded in filling the hole and in re-entering the drift, but the men could not continue the working; they were, according to the engineer's report, *driven out of it by the frequent bursts of sand and of water*, and it was acknowledged by him to be quite impracticable to proceed farther; so, after having probed the ground from underneath in many places, he concluded and reported that it was impossible to make an excavation of any size under the Thames. It never entered the head of this engineer, Mr. Trevethick, a remarkably ingenious and enterprising man, who conducted the operation to its final abandonment, that any covering, spread over the bottom of the river, would prevent the river filling his drift or a tunnel, at every tide, any more than it does the wells situated at many hundred yards from the river.

But he resorted to one expedient which he conceived would answer the emergency—one which, at any rate, demonstrates the intrepidity of this engineer. That is, in order to clear or pass through the place which had been filled up in closing the hole made by the breaking in of the river, he reduced the height of his drift from 5 feet to 3 feet. The men and the engineers, too, had therefore to work on their knees. Awful enough for such a task! Thus reduced, the area of the excavation of this drift hardly exceeded the one hundredth part of that of the Thames Tunnel under corresponding circumstances.

Any one can form an idea of a hole

three feet square by looking at some garret window; but not so easily of a hole of a greater sectional area—for example, than the old House of Commons was.

It is no absurdity, Mr. Editor, to have succeeded in cutting out a hole of larger area than that hall, under a head of water as high as the Custom-house. The engineer who has made it never, however, professed being a miner, and never excluded miners, or any person interested professionally, from a sight of his works.

Let us farther notice here what Mr. Vazie said, who was not only the colleague of Mr. Treveithick, but the directing engineer, so far at least as the first 392 feet of that drift. In his letter, by way of appeal, to the proprietors, dated the 7th of December, 1807, relying, as he somewhat emphatically assumed it, "*on his professional information in the art of mining*," he stated, "*I am bold to say, that the only material difficulties with which we have had to contend have arisen from not having had the* 50 *horse steam engine*," which had actually been purchased at his suggestion, and for which a 14-horse power had been substituted. He then adverts to "such an enterprise as that of working underneath a river so deep and so rapid as the Thames;" and boasts of having, nevertheless, "*succeeded in defiance of difficulties pronounced insurmountable by several engineers.*" In another part of his letter he adds, "I have been repeatedly, laboriously employed *through the night*, without taking any refreshment; and it was by no means unusual for me to remain 40 hours without rest; and for upwards of *four years and a half* I DID NOT SLEEP ONE NIGHT FROM THE WORKS—*I am proud to state this*, &c."

And all these arguments were from practical miners, who had but one miner and one carpenter to direct for making a shaft, begun on a diameter of 11 feet and completed at 8 feet; then carrying a driftway 5 feet in height, wherein not a single brick had been used.

Well may it be said, in respect to these great efforts towards making "convenient carriage-ways" *quite water-proof.*

"*Parturiens mons, nascitur ridiculus mus!*"

And now not a vestage can be traced of these vast labors.

But of the Thames Tunnel there is to be seen that which demonstrates the practicability of the plan of Mr. Brunel; and knowing that it has withstood the shock of two irruptions of the river, we have a sufficient security of the strength of the structure to assure us, that when completed it will endure—a lasting monument to national enterprise and zeal in promoting practical science. We may at this period repeat what his Grace the Duke of Wellington said of it in 1829, viz. "There is no work upon which the public interest of foreign nations has been more excited than it has been upon this tunnel;" and for a confirmation of the interest felt in our own country, we may refer your readers to the transactions in the House of Lords on the 2d of July, 1830, or of the House of Commons on the 24th of August last.

The reports of the former attempts and proceedings were published in 1809 by the Directors of the Company, when they made a public appeal for plans, offering a liberal reward for that which should be adopted. Fifty-three plans were obtained upon this appeal. The practical and scientific men, to whom they were referred for examination, concurred in opinion that none would answer for effecting the object on a proper scale. All farther attempt was in consequence given up by the Company. A subsequent one, by working from above the river, proved equally unsuccessful.

Had your correspondent, Mr. Editor, in No. 605, been as solicitous for correctness as he is familiar with censure, he would not have felt himself called on to reprobate the Lords of the Treasury for having granted 250,000*l.* for the completion of an enterprise, as far completed as it is, which had received the fullest and most unequivocal approbation of his Grace the Duke of Wellington; no mean authority in such matters, more particularly when he had made himself familiar with those facts and circumstances already stated, but which is attempted to be denied by your correspondent. Nor is it other than natural that the late First Lord of the Treasury, Lord Althorp, should have been influenced in his decision by such sentiments as those publicly expressed by his Grace; as, for instance, "that the novelty of the work, the difficulty of ascertaining the nature of the bed of the river, and the accidents to which such a work was liable, tended to increase the expense of this great undertaking, yet that the work itself had cost only 120,000*l.*;" that is, at the

period alluded to by his Grace, viz. the 11th of June, 1828, which included, however, the expense of the first eruption and part of that of the second. But up to the 31st of December, 1828, when the works were entirely suspended and were closed, the cost of the works of the tunnel, including the shield, the steam-engine, and a powerful pumping-apparatus, was not more than 126,740*l.*, including both accidents, instead of 240,000*l.*, as your correspondent asserts it. Adverting farther to the benefit which will result from the work by uniting populous districts, his Grace added, that "*men cannot but see the great political, military, and commercial benefits that will be derived from the example of such a work, in this and in other countries; that the accidents which have occurred have demonstrated the practicability of the enterprise, and the genius and the ability of the engineer who has conducted it; they have also proved this, that the work of itself is excellent*," &c.

This same correspondent remarks, that if the engineer had gone deeper with his tunnel, he would have avoided all difficulties and accidents. Now were he to refer to the reports of those engineers already alluded to, who operated between the years 1803 and 1808, he would find that they could not venture lower than 76 feet—which fact he will find to be confirmed by well-sinkers, who have opened wells near the river on the south side; and further, he may be informed, that eminent geologists have warned Mr. Brunel of the probable effects of the 50 feet bed of blowing sand existing below that depth, and that they recommended him to keep as near as possible to the river as, perhaps, the enemy least to be dreaded.

Notwithstanding the public acknowledgment by the Duke of Wellington of the utility of the undertaking, and of the national honor which is attached to its completion, and notwithstanding the confidence which even the most disastrous accidents have inspired in the plan, by which one half, or nearly, of the undertaking has been realised and carried to the deepest part of the river, another correspondent or contributor of yours in No. 626, subscribing himself *Fanqui*, excited evidently by some grievous disappointment, protests against the enterprise, premising with an eulogical preface on the present member for Berkshire for *his manly exposure* in the House of Commons, of the pretended *manœuvres of the patrons of the Thames Tunnel in obtaining* 270,000*l. from the Government*. This critic unhesitatingly affirms, that the work, "*if ever finished, will only be a monument of folly and absurdity, because no vehicles of any description will ever use it as a means of transit.*" And he concludes by asking, "*who were the three most eminent engineers who had examined the plans of that scientific engineer, Mr. Brunel?*"

The charge of folly and stupidity certainly possesses some novelty to those who have been taught to value the benefit of good communications across a large navigable river, as the Thames is all the way from London Bridge to its mouth, where a permanent land communication cannot possibly be obtained. But to his question. It may be replied, that the Duke of Wellington was the first eminent engineer who, as far back as the year 1820, had examined the plan, and who from that time to the present has continued to manifest great interest in its application. The late Dr. Wollaston may be considered the second who expressed himself most favorable to the plan, and, it may be added, that the name of Wollaston stands the first in the enterprise, and most prominent, not only in the list of subscribers, but of proprietors to this day. In Mr. Donkin may be found the third, a gentleman who, from his practical knowledge of machinery, was fully competent to judge as to the efficiency of the shield after he had examined it.

I cannot but give a specific denial to the assertion, that the speculation was one of those which take their date from the eventful years of 1825 and 1826, because the first meeting, convened by the friends of the enterprise for organizing a company, took place in December, 1823, and the subscriptions were made up at a General Meeting in February, 1824. Should your correspondent not be satisfied with the testimonies already adduced, we may refer him to a leading article in the *Times*, at that period conducted by the present member for Berkshire. The article in question is dated 4th July, 1828; consequently, after the two eruptions of the river. It is therein said, that "the Thames Tunnel is an undertaking of the highest national importance and credit, and such as ought to meet with the most ample public support in extricating it from its difficulties, and rendering it a proud monument of national utility and honor."

We may conclude, by informing your numerous readers and the public, that this national undertaking is in progress towards that anticipated achievement; and we may, on the best authority, add, that the front of the excavation has been worked and advanced several feet, and the ceiling of it raised in equal proportion; the whole having been done with perfect safety; and, moreover, that a considerable part of the old shield has been removed, and some portion of the new one has been put up. ‡.

SUSPENSION BRIDGE AT FRIBOURG.—The following account of the bridge at Fribourg, in Switzerland, was recently communicated to the French Academy by M. Arago:

Fribourg is built upon the left bank of the river Sarmi. This little river has very steep banks on both sides. Their height above the bed is about 200 feet (French). Travellers, in going from Berne to Fribourg, were obliged to descend a hill of 200 feet, in order to reach a little wooden bridge thrown over the river, and immediately afterwards to ascend another hill of the same height, in order to reach the middle of the town. The passage through Fribourg, therefore, in a carriage, took up nearly an hour. These delays and difficulties seemed the necessary result of its position, when some enterprising individuals conceived the possibility of executing a suspension bridge which might unite the summits of the two high hills, between which the Sarmi flows. The bridge was to pass over a great part of the town. The project seemed perfectly Utopian; nevertheless, the zeal of the citizens and magistrates induced them to submit the project to the attention of engineers in every country. The Cantonal Government gave the preference to the plan of M. Challey, of Lyons, and it has been executed under his immediate direction. The gates, by which we enter the bridge, are of the Doric order, and sixty feet high; the elevation of the arch is thirteen metres, the opening six metres; the breadth of the masonsy fourteen metres, its thickness six metres. Although immense blocks of hard limestone rock from the Jura have alone been used, it has been deemed necessary to unite them by strong metallic cramps; 25,000 kilogrammes of iron have been used for this purpose. The breadth of the valley of the Sarmi, at the spot where the bridge has been made, or the distance between the two interior faces of the gates thus raised upon both sides, or, in other words, the whole length of the bridge, is 817½ feet (French). It will easily be conceived there was some hesitation in attempting to pass this whole distance at one single cast or span, and the idea naturally suggested itself to M. Challey, of endeavoring to support it in the centre. But the difficulty of fixing solid piles at the height of 200 feet, especially in alluvial soil, made him relinquish it. The bridge, therefore, has only one span—a span of 265 metres. It is suspended according to principles, now generally acted upon, of four iron cables passing over the upper part of the two gates, each cable being composed of 1,200 iron wires, about three millimetres in diameter, and 347½ metres in length. As it would have been difficult to manage and to stretch these cables collectively, they were worked in separate parts. Their union was effected in the open air, the workmen being suspended, and, happily, without any accident having occurred. The four cables have been calculated to support 3,000,000 kilogrammes, equal to 60,000 ancient quintals. They are fastened, on the two banks, to the bottom of four pits excavated in the rock. In each pit, they are crossed by a vertical cylindrical shaft, which unites three massive superincumbent arches, and which are connected with infinite care with the surrounding rock. Lower down, they are let into very hard blocks of stone, of two cubic metres each. These cables, therefore, can only give way by tearing down the enormous weight of these several buildings, strengthened as they are, in every way, by adhesion to the rock. M. Challey began his work in 1832, assisted only by a person whom he brought with him from France, and employing merely the laborers of the country, men without experience, and who had never seen a suspension bridge. On the 15th October, 1834, fifteen pieces of artillery, drawn by forty-four horses, and surrounded by three hundred persons, passed the bridge, and went in a body, both to the middle and to the ends, without the least perceptible effect upon the efficiency of the bridge; and some days after, a procession, composed of the whole population of Fribourg and of the neighborhood, passed over with equal facility and confidence, although there never could have been less than eight hundred persons, many of them on foot, on the bridge at the same time. Since that, travellers and merchants have come in numbers to see this stupendous work. It is the intention of the engineer this month, (October, 1835,) to try the powers of the bridge by a weight of 100 kilogrammes to every square metre, and it may then be said, the Bridge of Fribourg has been executed in two years and a half.—The whole expense has been about 600,000 francs, or 25,000*l.* sterling. The only bridge which, for its dimensions, can be compared with that of M. Challey, is the Menai Bridge, built by the late Mr. Telford, and

which joins the Isle of Anglesey to England. The largest ships can pass under this bridge at full sail. But the breadth of the Menai Bridge is only 167½ metres, 516 feet—consequently 301 feet less than that of Fribourg. The surface of Mr. Telford's bridge is about 32½ metres, or 100 feet above the level of the sea at high water. That of M. Challey is 51 metres, or 156 feet above the bed of the Sarmi. M. Candolle has taken the city of Paris as a standard, by which to convey an idea of the magnitude of M. Challey's bridge. He supposes a bridge of only one single span, the length of which shall be equal to the railing of the Carousel, or to the distance between the two corresponding carriage entrances of the two galleries, the level of this bridge being somewhat lower than the height of the towers of Notre Dame, or eight metres higher than the column of the Place Vendome, and you may thus have some notion of the height and length of the bridge at Fribourg.—[London Courier.]

The Company of the Iron Railroad from Paris to St. Germain has obtained from the military authorities permission to occupy troops on that undertaking.

The survey for the establsihment of the Iron Railroad from Paris to Lille has been confided by the Administration of Bridges and Highways to M. Vallee. The plan is to make a communication between Paris and the Channel, at the ports of Calais, Boulogne, and Dunkirk; between Paris and Lille, Paris and Belgium, or Valenciennes; the Channel and Belgium, or between the ports of Calais, Boulogne, Dunkirk, and Valenciennes.—[London Courier.]

The Brussels and Antwerp Railroad.—This is, perhaps, the Railroad of all others which has been constructed at the smallest expense; for the intervening country is almost a dead level; and it is at the same time amongst the most successful. For some time it has been completed from the capital to Malines, which is considerably more than half way, and was far advanced towards the Scheldt, when an order was received, forbidding its further progress, upon the ground that approaching, as it would, so near the citadel of Antwerp, it might compromise the defences of that place. It now appears that the suggestion of this danger was first made by General Hano, of the French engineers.—[Ibid.]

New Liquor Guage.—A guage, upon a very simple and excellent principle, which has just been introduced in the new gin palaces, has been invented by Mr. Fage, the hydrometer manufacturer, to show the quantity of liquor, in inches, contained in a cask or vat at any time. The guage is a vertical glass tube of the same altitude as the cask or vat, and about the size of a large barometer tube, open at both ends. The lower end is securely let into a brass tube about 6 inches long, at right angles, with a valve, or stop-cock; this tube is fixed into the lower part of the side of the cask, as near the bottom as can be, similar to a cock. The glass tube is attached to a brass index about two inches wide, and of the same height as the glass tube, which is divided into inches; and the number of inches is engraved in figures reading from the bottom to the top. It is evident, when the valve at the foot of the glass tube is open, the liquor in the vat or cask will rise to the same height in the tube as it is in the vat; and, by means of the brass index, that it will show the number of inches of liquor in depth as there are in the vat or cask. It saves considerable labor and trouble to the excise officers; as, by calculating the quantity there is in each inch in depth in the cask when the guage is first fixed, they can make their entries without the trouble of the guaging rule.—[Architectural Mag.]

Extraordinary Invention of M. Sudre.—On Wednesday evening, M. Sudre delivered a lecture at the Mechanics' Institution, Liverpool, upon his system of universal musical language. The lecture room was crowded to excess. In order to remove all suspicion of collision, the pupil was placed in the apparatus room of the Institution, and the door closed. A short phrase or sentence, in English or French, was then successively written by a number of ladies and gentlemen in different parts of the room, and placed on the lecture table, so as to be seen by the lecturer, and him only. M. Sudre having tuned his instrument, a fine toned violin, drew his bow sharply across it, so as to produce a chord, the signal of commencement, and then played, as it were, the sentence before him on the violin. This was no sooner done than the pupil brought from the adjoining room a black board, and M. Sudre having written in chalk upon the black diagram board of the Institution the sentence communicated, the boards were compared, and found to correspond. As M. Sudre keeps the method by which he is enabled to make this communication a secret, under the expectation of Government patronage, we

can only speculate upon it. The sounds upon the violin seemed to be comprised within a scale of two octaves, and one sound appeared to be longer sustained than another. Though in this manner a musical alphabet might be composed, this cannot be the only means by which the sentence was conveyed, as we perceived (especially in the French) that the number of sounds were not equal to the number of letters. From this we are led to imagine that the system of M. Sudre must be a species of musical stenography, in which the vowels are occasionally omitted, and a simple sound used for a whole syllable or word.—[Liverpool Mercury.]

THE LABORING CLASSES IN EUROPE.—The North American Review for October, commences a discussion of this subject, which, if the conclusion equals the present portion, ought to be circulated by thousands, as a tract, throughout the land.

The writer of the interesting article to which we have just referred, notices the condition of the laboring classes in Europe, in respect "to the rate of wages, the burden of taxation, the means of subsistence, the facilities of acquiring education, and the share, if any, which these classes have in the government." The facts, in regard to each of these particulars, ought to make those hang their heads with shame, who, in this community, talk of the oppression of the laboring classes by the rich, and of the withholding of rights from the common people.

In Norway, "the ordinary food of the peasantry is bread and gruel, both prepared of oatmeal, with an occasional intermixture of dried fish. Meat is a luxury which they rarely enjoy."

In Sweden, the dress of the peasantry is prescribed by law. "Their food consists of hard bread, dried fish and gruel, without meat."

In Denmark, the peasantry are still held in bondage, and are bought and sold together with the land on which they labor."

In Russia, "the bondage of the peasantry is even more complete than it is in Denmark." The nobles own all the land in the empire, and the peasantry, who reside upon it, are transferred with the estate.

"A great majority have only cottages, one portion of which is occupied by the family, while the other is appropriated to domestic animals. Few, if any, have beds, but they sleep upon bare boards, or upon parts of the immense stoves by which their houses are warmed. Their food consists of black bread, cabbage, and other vegetables, without any addition of butter."

In Poland, "the nobles are the proprietors of the land, and the peasants are slaves." A recent traveller says, "I travelled in every direction, and never saw a wheaten loaf to the eastward of the Rhine, in any part of Northern Germany, Poland, or Denmark. The common food of the peasantry of Poland, 'the working men, is cabbage, potatoes, sometimes, but not generally, peas, black bread and soup, or rather gruel, without the addition of butter or meat."

In Austria, "the nobles are the proprietors of the land, and the peasants are compelled to work for their masters during every day of the week, excepting Sunday. The cultivators of the soil are in a state of bondage."

In Hungary their state is, if possible, still worse. The nobles own the land, do no work, and pay no taxes. The laboring classes are obliged to repair all the highways and bridges, are liable at any time to have soldiers quartered upon them, and are compelled to pay one-tenth of the produce of their labor to the church, and one-ninth to the lord whose land they occupy.

Of the people of France, "seven and a half millions do not eat meat, or wheaten bread. They live upon barley, rye, buckwheat, chesnuts, and a few potatoes." [We saw it stated, the other day, that some workmen, we forget in what part of New-England, had a turn-out because their employers would not furnish them with tea and coffee at dinner!]

The common wages of a hard laborer, in France, is $37 50 for a man, and $18 75 for a woman, annually. "The taxes upon the land are equal to one-fifth of its nett products."

In 1791, there were 700,000 houses in Ireland. Of these, 113,000 were occupied by paupers—and more than 500,000 had only one hearth. The average wages of a laborer is from nine and a half to eleven cents a day.

Among the laboring classes of the industrious Scotch, "meat, except on Sundays, is rarely used."

In England, the price of labor varies. "The Nottingham stocking-weavers, as stated by them in a public address, after working from fourteen to sixteen hours in a day, only earned from four to seven shillings a week, and were obliged to subsist upon bread and water, or potatoes and salt!"